



## Chapter 8 Environmental and Social Considerations

### 8-1 Relevant Legal Framework on the Environmental and Social Considerations in Nigeria

#### 8-1-1 Legal Framework

##### (1) The Constitution of the Federal Republic of Nigeria

The Constitution of the Federal Republic of Nigeria 1999 describes the importance of the environmental protection and improvement and relationship between fundamental human rights and the environment as follows:

- Article 20: The state shall protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria.
- Article 12: The National Assembly may legislate for the Federation or any part thereof with respect to matters not included in the Exclusive Legislative List to implement a treaty.
- Articles 33 and 34: Every person has the right to life and no-one shall be intentionally deprived of their life, save in execution of the sentence of a court with respect to a criminal offence of which he/she has been found guilty in Nigeria. Every individual is entitled to respect for the dignity of his/her person and accordingly (a) no person shall be subject to torture or inhuman or degrading treatment; (b) no person shall be held in slavery or servitude; and (c) no person shall be required to perform forced or compulsory labor.

##### (2) Environmental legislation

In Nigeria, while no comprehensive “environmental protection law” concerning environmental protection, conservation and management has yet been established, environmental laws and regulations concerning each environmental topic are enacted. The laws and regulations related to this project are listed below.

**Table 8-1.1 Environmental legislation**

Legislation	Description	Year
The Land Use Act	All Land comprised in the territory of each state solely in the Governor of the State, who would hold such Land in trust for the people and henceforth be responsible for allocating land in all urban areas to individual residents in the state and to organizations.	1990
Environment Impact Assessment Act	Any development projects which would potentially harm the environment must have an EIA conducted.	1992
The Nigerian Urban and Regional Planning Act	The Act aims to ensure realistic and purposeful planning of the country to avoid overcrowding and poor environmental conditions.	1992
Endangered Species Act	The Act focuses on protecting and managing Nigerian wildlife and some of their species threatened with extinction as a result of overexploitation.	1985
Water Resources Act	The federal government of Nigeria has the sole right to utilize and manage all surface water, groundwater and any water channels which affect more than two states.	1993

Legislation	Description	Year
Federal National Park Service Act	Protected areas are set up under the Act for natural resource protection, wildlife conservation and maintenance of the national ecosystem.	1999
Forest Law	The Law regulates forest reserve designation and management. However, it is obsolete and enforcement is very weak. <sup>1</sup>	1956

Source: JICA Study Team

### (3) Environmental regulations

One of FMEnv's parastatals, the National Environmental Standards and Regulation Enforcement Agency (NESREA) established in 2007, is responsible for developing and managing environmental standards and other regulations for environmental protection and management. There are more than 20 regulations and those related to the project are shown below. Four regulations, including one for the energy sector, were newly issued at the end of 2015.

**Table 8-1.2 Environmental regulations**

Regulation	Year
S.I.8 National Environmental protection (Effluent Limitation) Regulations	1991
S.I.9 National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Waste) Regulations	1991
National Environmental (Permitting and Licensing Systems) Regulations	2009
National Environmental (Sanitation and Waste Control) Regulations	2009
National Environmental (Noise Standards and Control) Regulations	2009
National Environmental (Watershed, Hilly, Mountainous and Catchment Areas) Regulations	2009
National Environmental (Wetlands, River Banks and Lake Shores Protection) Regulations	2009
National Environmental (Coastal and Marine Area Protection) Regulations,	2011
National Environmental (Surface and Groundwater Quality Control) Regulations	2011
National Environmental (Protection of Endangered Species in International Trade) Regulations	2011
National Environmental (Construction Sector) Regulations	2011
National Environmental (Energy Sector) Regulations	2014
National Environmental (Hazardous Chemicals and Pesticides) Regulations	2014
National Environmental (Air Quality Control) Regulations	2014
National Environmental (Dam and Reservoirs) Regulations	2014

National Environmental (Energy Sector) Regulations (2014) are applied to power generation facilities with fossil fuel, renewable energy and nuclear and transmission lines. It stipulates obligatory environmental audit and monitoring, reporting to NESREA, monitoring methods, a permit system for emissions, as well as emission standards and health and safety.

### (4) Land acquisition/resettlement legislation

In general, land acquisition is carried out under the Land Use Act (1978). In addition, for the power sector, the Nigerian Electricity Regulatory Commission (Acquisition of Land and Access Rights for Electricity Projects) Regulations (2012) is applied. In addition, supported by the World Bank, the Resettlement Policy Framework for Nigeria Electricity and Gas Improvement Project (NEGIP) was developed in 2008 as a framework for land acquisition and resettlement in the power sector (including transmission lines). Using the framework, TCN prepared a resettlement action plan for the World Bank's

<sup>1</sup> FMEnv, the Cross River State's Forestry Commission and UNDP. A Preliminary Assessment of the Context for REDD in Nigeria (2010).

58 km 330 kV Qit –Ikot Abasi Transmission Line Project.

## **(5) Other policies**

### **1) National policy on the environment (1991)**

This policy, established in 1991, requires environmental concerns and sustainability to be integrated with development and presents specific guidelines for achieving sustainable development in 14 main sectors of Nigeria's economy<sup>2</sup>. Although the policy was once reviewed in 1999, a further review of the policy is now ongoing with UNDP's support because more than 20 years have elapsed since it was first released.

### **2) National Forest Policy (2006)**

Instead of the outdated Forest Law, this policy acts to underpin forest management in Nigeria. Its overall objective is to achieve sustainable forest management that would ensure sustainable increases in the economic, social and environmental benefits from forests and trees for present and future generations.

## **8-1-2 Climate Change**

In Nigeria, the agriculture and food security, water resources, public health and settlements sectors are particularly vulnerable to climate change. The most vulnerable regions are the coastal region in the southeastern part of the country and the northern area, where erosion and desertification are progressing. The worst case estimated in the coastal region is that the sea level would rise 1 m and the temperature increase 3.2 deg. C from the 1990 level. Department The of Climate Change (DCC) in FMEnv is responsible for coordinating the national implementation of climate-change measures and helping establish a Climate-Change Unit within other federal ministries to prioritize climate-change issues in mainstream policy-making and activity-planning. The following summarizes climate change in-country measures related to the energy sector. Nigeria's INDC as announced at COP 21 has been prepared in line with the following policies (see Chapter 5 for INDC).

The National Policy on Climate Change (NPCC) is the latest set of national policy documents regarding climate change. As a strategic goal for climate-change countermeasures, the NPCC declares its efforts to build a low-carbon society and promote high economic growth for a strong society acting against climate-change. Regarding energy use, since it occupies an important role in Nigerian economic growth, strategies in the energy sector are set out allowing climate change to be tackled from the broad context of sustainable development.

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<sup>2</sup> Human Population; Land Use and Soil Conservation; Water Resource Management; Forestry, Wildlife and Protected Natural Areas; Marine and Coastal Area Resources; Sanitation and Waste Management; Toxic and Hazardous Substances; Mining and Mineral Resources; Agricultural Chemicals; Energy Production; Air Pollution; Noise in the Working Environment; Settlements; Recreational Space, Green Belts, Monuments and Cultural Property.

**Table 8-1.3 Strategy and Measures in National Policy on Climate Change**

Challenge	Producing adequate energy for the country Minimizing GHG emissions in the process
Strategies	Promoting a diverse energy mix with an increasing proportion contributed from renewable and other sources using clean technologies Improving energy efficiency in various sectors Strengthening private sector participation to produce and use clean energy
Activities	Reviewing the implementation of existing national energy policies, plans and regulations to make them responsive to mitigating GHG emissions as well as increasing national adaptive capacity to climate-change impacts in terms of: Eliminating subsidies on fossil fuel Subsidizing the development of renewable and other clean energy sources Standardizing energy equipment, vehicles, power generation systems and consumption in homes, offices and industries toward boosting energy efficiencies Decreasing the use of fuel (heavy) oil Generating energy from renewable sources to account for a minimum of 20% by 2030. Re-engineering thermoelectric plants with combined-cycle technology Strengthening fiscal and regulatory measures to actively encourage private power companies in producing power Promoting targeted research in low-carbon technologies and renewable energy sources Supporting households to take the required actions to use domestic energy efficiently Supporting the ongoing effort to upgrade energy infrastructures, including transmission lines, to improve supply efficiency Expanding the national grid coverage to meet electric power demand, particularly at the grassroots Supporting the ongoing initiative to gradually eliminate gas flaring Promoting the more efficient use of oil and gas

Source: JICA Study Team in reference to the National Policy on Climate Change

### 8-1-3 Multilateral Environmental Agreements

Nigeria is a member country in the following Multilateral Environmental Agreements (MEAs), which have tackled global environmental problems, such as hazardous material management, climate change, ozone depletion, biodiversity protection and waste management. Meanwhile, domestic legislation related to MEAs remains poorly developed.

**Table 8-1.4 Multilateral Environmental Agreements**

Category	Agreements	Domestic legislation
Hazardous materials	Stockholm Convention on Persistent Organic Pollutants (POPs)	-
Hazardous materials	Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for certain Hazardous Chemicals and Pesticides in International Trade 1998	○
Hazardous materials	Protocol Concerning Cooperation in Combating Pollution in case of Emergency	-
Waste management	Bamako Convention on the Ban of import into Africa and Trans-boundary Movement of Toxic and Hazardous Waste 1991	-
Biodiversity	International Plant Protection Convention 1951	-
Biodiversity	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	○
Biodiversity	Cartagena Protocol on Bio-safety to the Convention on Biological Diversity	-
Biodiversity	Convention on Biological Diversity 1993	-
Biodiversity	Bonn Convention on the Conservation of Migratory Species of Wild Animals 1979	-
Climate change	Ramsar Convention on Wetlands of International Importance	-
Climate change	United Nations Framework Convention on Climate Change (UNFCCC)	-
Climate change	Kyoto Protocol to the UNFCCC	-

Category	Agreements	Domestic legislation
Ozone depletion	The 1985 Vienna Convention for the Protection of the Ozone Layer	-
Ozone depletion	Montreal Protocol on Substances that Deplete the Ozone Layer 1987	-
Ozone depletion	London, Copenhagen and Montreal Amendments to the Montreal Protocol on substances that deplete the ozone layer	-
Ozone depletion	The Beijing Amendment (1999) to the Montreal Protocol on Substances that deplete the ozone layer	-
Desertification	International Convention to Combat Desertification and Drought Mitigation in Countries Experiencing Serious Drought and/or Desertification, Especially in Africa	-
Marine environment	Convention relating to the intervention on the High Seas in cases of Oil Pollution Casualties 1969	-
Marine environment	United Nations Convention on the Law of the Sea	-
Marine environment	International Convention on the prevention of Marine Pollution by Dumping of Waste and other Matter 1972	○
Marine environment	International Convention for the Control and Management of Ship's Ballast Water and Sediments of 2004	-
Marine environment	Convention on Fishing and Conservation of the Living Resources of the High Seas	-
Marine environment	International Convention for the prevention of pollution from ships 1973 as modified by protocol of 1978 (MARPOL)	-
Marine environment	Convention on Cooperation in Protection and Development of Marine and Coastal Environment of West and Central Africa Region	-

Source: JICA Study Team

## 8-1-4 Institutional Framework

### (1) Federal Ministry of the Environment

The Federal Ministry of the Environment (FMEnv) was established in 1999 to administer and integrate environmental protection in Nigeria, including the development of national policies concerning environment and natural resource conservation, advising other ministries and agencies and setting up regulations and standards. The organizational structure of FMEnv is shown below.



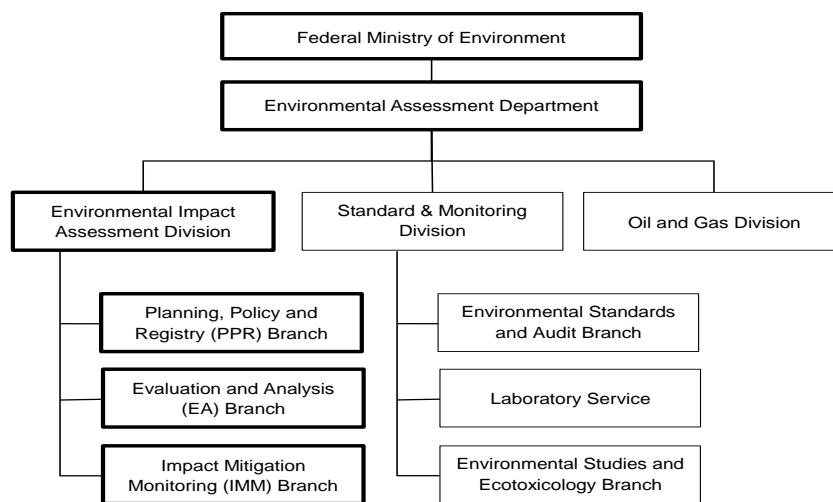
Source: FMEnv website

**Figure 8-1.1 Organization chart of FMEnv**

The Environmental Assessment Department (EAD) under FMEnv is in charge of the Environmental

impact assessment (EIA) in Nigeria. Figure 8-1.2 shows the structure of related organizations. The legal system, procedures and approval for EIA review is carried out by the Environmental Impact Assessment Division (EIAD), the functions of which are as follows:

- Planning, Policy and Registry (PPR) Branch: In charge of the EIA of newly registered projects, collecting and managing registration fees, training, workshops, conferences and seminars, accounting and site inspection of new projects, etc.
- Evaluation and Analysis (EA) Branch: In charge of the EIA scoping, risk assessment, Terms of Reference (TOR) and the review and evaluation of the EIA report
- Impact Mitigation Monitoring (IMM) Branch: In charge of the monitoring of EIA-approved projects, auditing and post-project evaluation, etc.

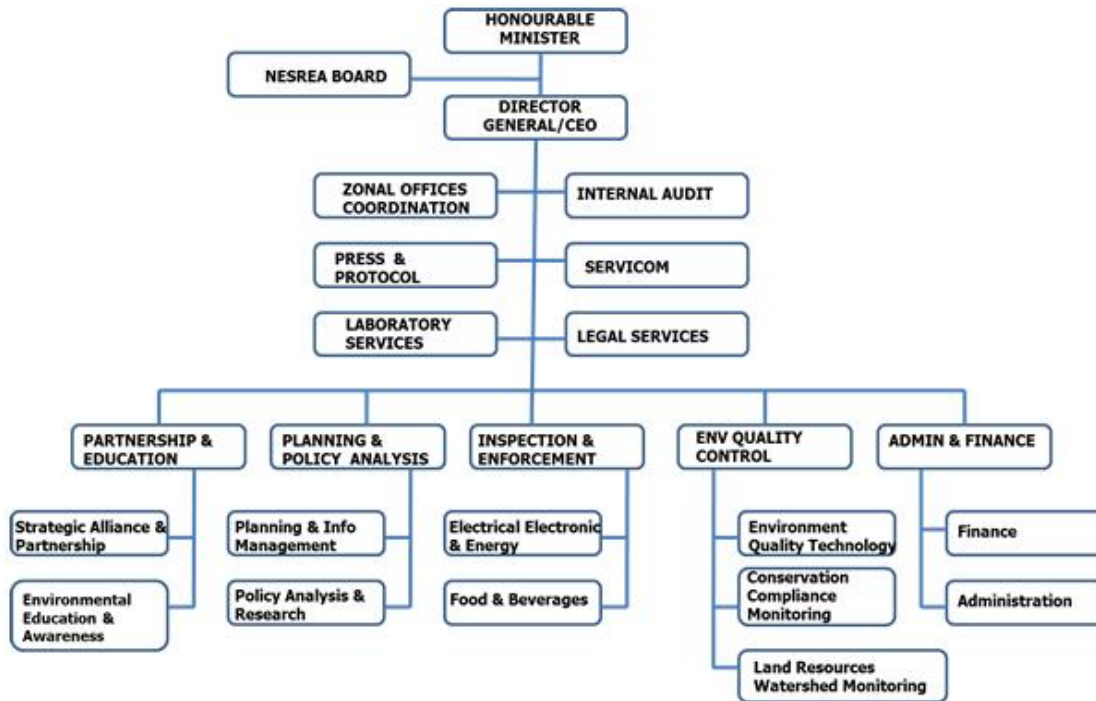


Source: JICA Study Team based on FMEnv document

**Figure 8-1.2 EAD Organizational Chart**

## (2) National Environmental Standards and Regulations Enforcement Agency

The National Environmental Standards and Regulations Enforcement Agency (NESREA), one of the parastatals, is in charge of developing and implementing Nigeria's environmental standards and regulations nationwide and also responsible for strengthening compliance with international treaties, agreements and convention related to the environment. The organizational structure of NESREA is shown below. It is headquartered in Abuja, with six branch offices and 22 state offices.



Source: NESREA website

**Figure 8-1.3 Organizational chart of NESREA**

### (3) State Ministry of the Environment

Rather than being the authority to approve EIA, the state Ministry of the Environment participates in the technical reviews and review committees of the EIA approval process and advises businesses in the project formation stage. FME<sub>env</sub> is currently considering vesting the right of EIA approval for small-scale projects to the state Ministry of the Environment. Some states such as Lagos state also have their own environmental bylaws.

### (4) Federal Ministry of Power, Works and Housing (FMPWH)

The FMPWH has no specific department or unit responsible for environmental management. Instead, an environmental management unit (EMU) is usually organized on a project basis with outsourced environmental experts. FMPWH engineers are also assigned in the EMU, but their main task is to coordinate with FMPWH and EIA consultants.

In conjunction with recent Nigerian power sectoral reform, the Climate-Change Unit (CCU) was newly established in 2013 to promote awareness of climate change and encourage the sustainable development of the power sector. After merging with the Gender Unit, CCU became Climate Change, Gender and Human Resources Unit (CCGHRU), now also overseeing gender and human rights issues.<sup>3</sup> However, CCU has only one member of staff (Deputy Director) recently assigned and full-scale activities will be implemented later, after preparing an organization and activity plan.

<sup>3</sup> The ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) targets gender mainstreaming in energy access.



## **(5) Transmission Company of Nigeria (TCN)**

The Health Safety & Environment (HSE) Unit handles environmental management on TCN activities, including EIA coordination and consultations. The HSE Unit usually works closely with EIA consultants, particularly in stakeholder meetings for each TCN project.

## **(6) Nigerian Electricity Regulatory Commission (NERC)**

The Nigerian Electricity Regulatory Commission (NERC) administers the power sector's occupational health and safety regulations in cooperation with FMEnv and other agencies. NERC developed a Health and Safety Manual in 2008 and the Nigerian Electricity Health & Safety Code in 2014, which is imposed on each operator.

### **8-1-5 Environmental Impact Assessment (EIA)**

#### **(1) General**

In Nigeria, the EIA Act requires an EIA for all projects that may harm the environment. The following guidelines are used when developing an EIA:

##### **1) EIA Procedural Guideline (1992)**

The guideline describes the EIA preparation process (from project planning through to commencement) and its approval procedure and EIA.

##### **2) EIA guidelines for the power sector**

The guideline developed in 2013 is specialized for the power sector, covering present and future norms of energy production in Nigeria<sup>4</sup>. Despite the lack of nuclear power plants in Nigeria, a guideline for nuclear power plant projects has been developed. Notable differences in contents between the power sector guidelines and nuclear plant guidelines concern radioactive effects, spent nuclear fuel and radioactive waste, while the other contents are similar.

#### **(2) Project classification**

According to the EIA Act, all development projects are classified into three categories depending on the degree of potential environmental impact.

- Category I: where a full-scale EIA study is necessary for approval (equivalent to Category A in the JICA Guidelines)
- Category II: An IEE-level study is necessary for approval (equivalent to Category B in the JICA Guidelines)
- Category III: No EIA or IEE study is necessary for approval

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<sup>4</sup> Hydro-electric power generation, thermal (fossil fuel) power generation, boilers (steam turbines), reciprocating engines, combustion turbines, combined cycle, cogeneration, wind energy generation, nuclear power plants, electric transmission lines, rural electrification, solar power plant, biomass power plants, tidal electric power plants and geothermal plants.

In addition, projects in Sensitive Areas with the following characteristics shall be classified into Category I (EIA Procedural Guidelines 1995).

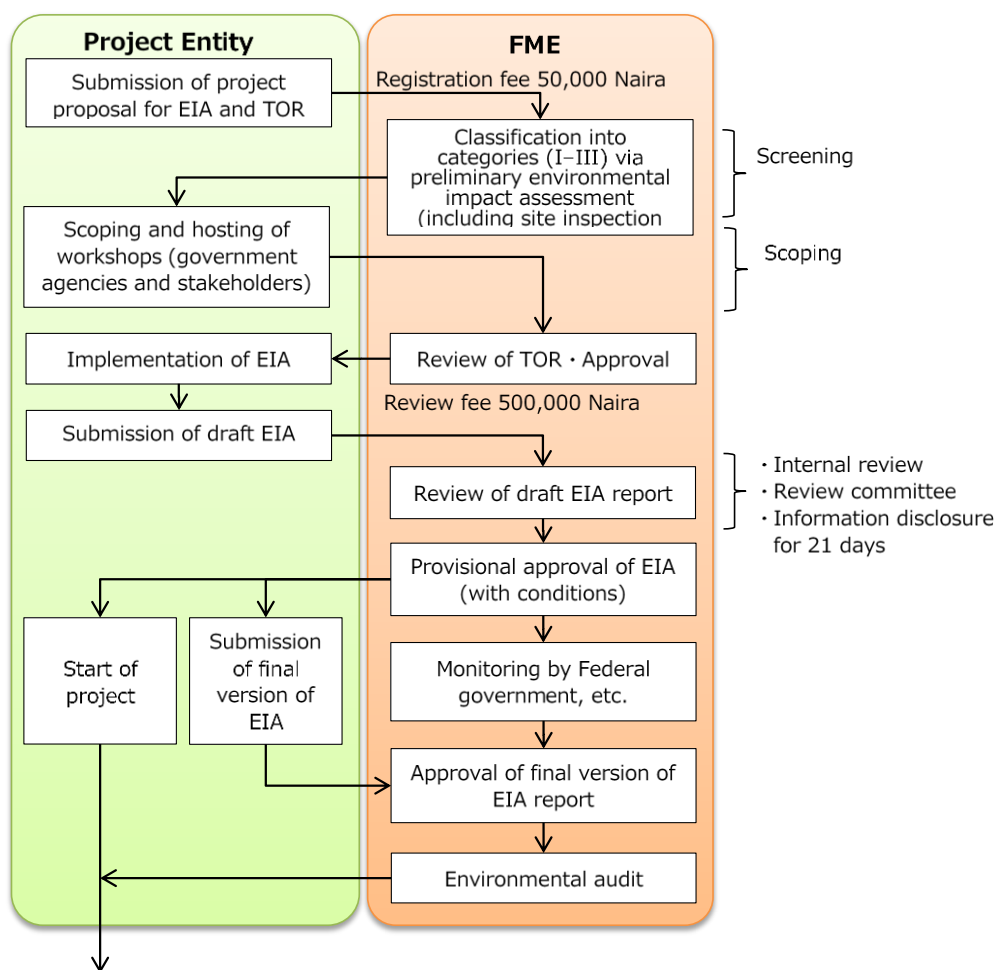
S-1	Coral reefs
S-2	Mangrove swamps
S-3	Small islands
S-4	Tropical rainforest
S-5	Areas with erosion-prone soils
S-6	Mountain slopes
S-7	Areas prone to desertification (and semi-arid zones)
S-8	Natural conservation areas
S-9	Wetland of national or international importance
S-10	Areas with harbor protected and or endangered species
S-11	Areas of unique scenery
S-12	Areas of particular scientific interest
S-13	Areas of historical or archeological interest
S-14	Areas of importance to threatened ethnic groups

For power sector, projects which satisfy the following criteria in accordance with the Schedule of EIA Act require EIA implementation. It is notable that criteria for transmission line projects are not clearly described in the Schedule.

- Power stations: capacity exceeding 10MW
- Hydroelectric power: (i) dams over 15 meters high and ancillary structures covering a total area exceeding 40 ha and/or (ii) reservoirs with a surface area exceeding 400ha
- Combined-cycle power stations
- Nuclear-fueled power stations

### **(3) EIA administration**

Figure 8-1.4 shows a flow chart of the EIA process in Nigeria. Depending on the project characteristics, the period from submitting the draft EIA report to the FMEnv to provisional approval is approximately 7 months to one year. EIA and IEE should be conducted by FMEnv-registered consultants.



Source: JICA Study Team in reference to FMEnv documents

**Figure 8-1.4 EIA administration procedure in Nigeria**

#### (4) Information disclosure and stakeholder meetings

Although the terms “Stakeholder” or “Public participation” cannot be found in the EIA Act, some descriptions regarding information disclosure and public participation, from the screening stage through the EIA review stage, are mentioned as follows. The lack of any description regarding stakeholder or scoping by project proponents during the EIA study. In practice, for the EIA process in the power sector, public consultations are often held at the scoping stage and stakeholder meetings have recently become popular throughout the EIA process as required.

- General: The Agency (FMEnv) shall give members of the public etc. the opportunity to comment on the EIA of the activity. [Article 7]
- Screening stage: Every screening or mandatory study of a project shall include comments concerning the effects perceived by the public. [Article 17]
- Review of the draft EIA report stage: A review panel shall hold a hearing in a manner that offers the

public an opportunity to participate in the assessment. [Article 37]

- Public comment: After receiving a mandatory study report concerning a project, the report shall be publicly available and any person may file comments with the Agency relating to the conclusions and recommendations of the mandatory study report. [Article 25]

## **(5) Revised EIA Act**

Currently the EIA Act revision process is ongoing. FMEnv disclosed the first draft of the revised Act on FMEnv's website and stakeholder consultations were held for 2 days in June 2015. More than 300 people including ministries, agencies, business entities and NGOs were participated. Comments and issues pointed out during the consultations were reviewed and FMEnv has already submitted the final draft to the National Assembly for the approval. According to FMEnv, the revised EIA system will fundamentally stay the same as the current system, except that the revised Act gives the authority partially from FMEnv to state Ministry of the Environment regarding EIA approval and introduces a new SEA system. Remarkable changes in the draft are shown below.

### **1) EIA mandatory study activities**

Schedule 1 of the draft Act describes activities and criteria for the power sector which require EIA studies, as follows (underlined areas indicate new changes). The criteria for transmission lines are not clearly stated, as in the original Act.

- Power stations: capacity exceeding 10MW
- Dual-fired (natural gas/diesel) power plants: capacity of (exceeding) 30 MW
- Hydroelectric power: (i) dams over 15 meters high and ancillary structure covering a total area exceeding 40 ha and/or (ii) reservoirs with a surface area exceeding 400ha
- Combined-cycle power stations
- Nuclear-fueled power stations
- Renewable energy plant (hydro, wind and solar)
- Waste to energy plants

### **2) Information disclosure and stakeholder meetings**

According to the revised Act (draft), an EIA shall include "evidence of effective consultation with relevant stakeholders including state, local government and community(ies) where the proposed project shall be located." (Article 5), which will strengthen stakeholder meeting implementation. In addition, Schedule II describes an EIA procedure including stakeholder meetings as follows:

- Scoping stage
  - Public consultation/scoping workshop as may be required
- Public consultation (examples)
  - Public forum (public hearing, focal group discussion etc.)
  - Stakeholders' workshop
  - Public review/public disclosure
- Review of the EIA report
  - Public disclosure (if applicable)

### 8-1-6 Strategic Environmental Assessment (SEA)

To date, there has been no Strategic Environmental Assessment (SEA) legislation in Nigeria. However, considering the intensified international focus on SEA implementation, the revised EIA Act (draft) will incorporate the SEA requirement as follows:

54. Strategic Environmental Assessment  
A Strategic Environmental Assessment shall be required where:

- (a) Wide-ranging government, public and private policies, plans and programs are to be implemented;
- (b) Small-scale projects are required on a statewide or regional basis and the project(s) do(es) not constitute (a) major project requiring a Standalone Environmental Impact Assessment.

58. Power to make Regulations  
The Minister may make regulations, published in the Gazette- (abbreviated)

- (d) prescribing a list of plans, policies and programs for which Strategic Environmental Assessment (SEA) is required.

60. Interpretation  
"Strategic Environmental Assessment" means a proactive tool that provides decision-makers and stakeholders with information on the environmental implications of a Plan, Program or Policy before major alternatives and directions have been chosen. A Strategic Environmental Assessment is the systematic and comprehensive process of examining environmental effects, significant economic and social effects to promote integrated decision-making.

FMEnv has not experienced SEA directly and few SEA studies have been conducted nationwide. Although FMEnv is planning to develop SEA regulations and guidelines in the near future, the timeline for the development remains unclear. Table 8-1.5 shows donor's projects with SEA level studies in Nigeria. FMEnv expects to earn SEA experiences and improve knowledge from such donor SEAs.

**Table 8-1.5 Projects with SEA level study**

Sector	Project	Organization	Period	C/P	Description
Power	Development of Gas-fired, Solar and Mini-hydro Power Generation Plants by Independent Power Producers (IPPs) in	World bank	Oct. 2015-	TCN (PMU)	The overall objective is to prepare a Strategic Environmental and Social Assessment (SESA) for private sector development of gas-fired, solar and mini-hydropower generating capacity in Nigeria, being addressed at the individual project level by preparing the environmental and social impact

Sector	Project	Organization	Period	C/P	Description
	Nigeria (Nigeria Electricity and Gas Improvement Project (NEGIP))				assessments (ESIA). It can be made more efficient and effective, however, through a sector-wide examination of the potential impacts. This is the main focus of the SESA while the strategic level to integrate principles of sustainable development “upstream” for decision-making remains the second focus.
Power	Screening of Potential Hydropower Options with Associated Water Resources Development in the Niger Basin	World bank	May 2015-	TCN (PMU)	SESA study is in operation to screen potential hydropower options with associated water resource development in the Niger Basin. Some of the objectives involve identifying the sub-basins most suitable for cascade development, sub-basins where no development should take place and those where development can take place under specific conditions, providing initial environmental and social impact assessment (cumulative impact inclusive). The study also serves as a methodological framework for a project-level environmental monitoring plan.
Water resources	Project for Review and Update of Nigeria National Water Resources Master Plan	JICA	- Jan. 2014	Federal Ministry of Water Resources	The previous version of the JICA Guidelines (2004) was applied for the project. A comparison of alternatives for the catchment management plan was made based on general SEA concepts.
Agriculture	Agricultural Transformation Agenda Support Program - Phase 1 (ATASP-1)	AfDB	- Jul. 2013	Federal Ministry of Agriculture	Aiming to support Nigeria’s Agricultural Transformation Agenda, the program includes infrastructure Development and commodity value chain development. SESA studies policy, legal and administrative framework, description of the program environment, comparison of alternatives, impact assessment and the environmental monitoring plan (framework). Individual environmental monitoring plan is to be prepared by each project proponent.

Source: JICA Study Team

### 8-1-7 Environmental Quality Standards and Related Regulations in Nigeria

In Nigeria, the following guidelines and legislation are mainly used in practice for pollution control in the power sector. No environmental standards or regulations are set out for vibration and soil contamination. Recently, the National Environmental (Energy Sector) Regulations 2014 have been issued, which comprehensively summarize emission standards and related power sector requirements.

- National Environmental (Energy Sector) Regulations 2014
- National Environmental (Air Quality Control) Regulations 2014
- National Environment (Surface and Groundwater Quality Control) regulations 2011
- National Environmental (Noise Standards and Control) Regulations 2009
- National Environmental protection (Effluent Limitation) Regulations 1991
- National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Waste) Regulations 1991

NERC, a regulatory authority, also regulates environmental, health and safety practices, prepares guidelines for the power sector and NESREA frequently revises their regulations. Accordingly, it is necessary to confirm applicable domestic regulations and laws with the relevant authorities when an individual F/S study is launched. If significant gaps emerge in comparison with international best practices or no domestic laws exists, it is desirable that project specific environmental standards be set; taking into account the project location, characteristics and international standards such as IFC Environmental, Health and Safety Guidelines.

**(1) Air quality**

**1) Environmental quality standards**

Ambient air quality standards in Nigeria are shown in Table 8-1.6. For facilities which emit exhaust gas, the air quality at the site boundary and in the neighboring area shall be less than 60% of the ambient air quality standards, assuming no cumulative impact from other facilities.

**Table 8-1.6 Nigeria’s ambient air quality standards**

Item	Averaging period	Standards	WHO Guidelines (reference)
SO <sub>2</sub>	1 Year	80 µg/m <sup>3</sup>	—
	24 hours	120 µg/m <sup>3</sup>	125 µg/m <sup>3</sup> (Interim target 1) 50µg/m <sup>3</sup> (Interim target 2) 20µg/m <sup>3</sup> (guideline)
	1 hour	350 µg/m <sup>3</sup>	—
NO <sub>2</sub>	1 Year	80 µg/m <sup>3</sup>	40 µg/m <sup>3</sup> (guideline)
	24 hours	120 µg/m <sup>3</sup>	—
	1 hour	200 µg/m <sup>3</sup>	200 µg/m <sup>3</sup> (guideline)
CO	8 hours	5.0 mg/m <sup>3</sup>	—
	24 hours	—	—
	1 hour	10 mg/m <sup>3</sup>	—
PM10	1 year	60 µg/m <sup>3</sup>	70 µg/m <sup>3</sup> (Interim target 1) 50µg/m <sup>3</sup> (Interim target 2) 30µg/m <sup>3</sup> (Interim target 3) 20µg/m <sup>3</sup> (guideline)
	24 hours	150 µg/m <sup>3</sup>	150 µg/m <sup>3</sup> (Interim target 1) 100 µg/m <sup>3</sup> (Interim target 2) 75 µg/m <sup>3</sup> (Interim target 3) 50 µg/m <sup>3</sup> (guideline)
	1 hour	—	—
O <sub>3</sub>	8 hours	100 µg/m <sup>3</sup>	160 µg/m <sup>3</sup> (Interim target 1) 100 µg/m <sup>3</sup> (guideline)
	1 year	180 µg/m <sup>3</sup>	—
Lead (Pb)	1 year	1.0 µg/m <sup>3</sup>	—
	24 hours	1.4 µg/m <sup>3</sup>	—
Arsenic (As)	1 year	6,000 µg/m <sup>3</sup>	—
Nickel (Ni)	1 year	20,000 µg/m <sup>3</sup>	—
Cadmium (Cd)	1 year	5,000 µg/m <sup>3</sup>	—
Ammonia (NH <sub>3</sub> )	1 year	0.2 mg/m <sup>3</sup>	—
	24 hours	0.6 mg/m <sup>3</sup>	—

Source: National Environmental (Air Quality Control) Regulations 2014, IFC EHS Guidelines

## 2) Emission standards

National Environmental protection (Effluent Limitation) Regulations 1991 has been substituted to National Environmental (Energy Sector) Regulations 2014 for emission standards from new fossil fuel power plants, as shown below.

**Table 8-1.7 Nigeria's air emission standards in the power sector**

No.	Pollutants	Fuel type		
		Coal	Oil	Gas
1	Sulfur dioxide (SO <sub>2</sub> ) (ppm)			
	>500 MW	320	320	20
	300-500MW	450	450	20
	<300MW	640	640	20
2	Nitrogen dioxide (as NO <sub>2</sub> ) (ppm)	350	180	120
3	Particulates (mg/m <sup>3</sup> )	120	120	60

\* Reference conditions are at 1 atm or 760mmHg dry basis, excess air of 50% or excess O<sub>2</sub> of 7%.

Source: National Environmental (Energy Sector) Regulations 2014

## (2) Water quality

### 1) Environmental quality standards

The National Environmental (Surface and Groundwater Quality Control) Regulations, 2011 apply to the environmental quality of surface water in Nigeria. Surface water types and applicable environmental standards are shown below.

**Table 8-1.8 Nigeria's environmental water quality standards (surface water)**

Item	Standards	
	Effluent discharges. Irrigation and reuse	Fisheries and recreation
<b>Physicochemical properties</b>		
Water temperature	Temperature by a 7-day daily average of the daily maximum temperatures shall not exceed $\pm 0.3$ deg. C above natural background conditions (except designated thermal mixing zones)	
DO	$\geq 4.0$ mg/l	$\geq 6.0$ mg/l
Color and turbidity	$\leq 10$ NTU of background	
pH	6.5 – 8.5	6.5 – 8.5
SS	0.75 mg/l	0.25 mg/l
BOD <sub>5</sub>	6.0 mg/l	3.0 mg/l
COD	30.0 mg/l	30.0 mg/l
<b>Chemical properties</b>		
NH <sub>4</sub> <sup>+</sup>	2.0 mg/l	0.05 mg/l
NO <sub>2</sub> <sup>-</sup>	0.08 mg/l	0.02 mg/l
NO <sub>3</sub> <sup>-</sup>	40.0 mg/l	9.1 mg/l
Phosphates (PO <sub>4</sub> <sup>3-</sup> )	3.5 mg/l	3.5 mg/l
Cl <sup>-</sup>	350 mg/l	300 mg/l
SO <sub>4</sub> <sup>2-</sup>	500 mg/l	100 mg/l
Oil and grease	0.1 mg/l	0.01 mg/l
Na <sup>+</sup>	120 mg/l	120 mg/l
K <sup>+</sup>	50.0 mg/l	50.0 mg/l
Ca <sub>2</sub> <sup>+</sup>	180 mg/l	180 mg/l
Mg <sub>2</sub> <sup>+</sup>	40.0 mg/l	40.0 mg/l
Total iron (Fe <sub>2</sub> <sup>+</sup> /Fe <sub>3</sub> <sup>+</sup> )	0.5 mg/l	0.05 mg/l



Item	Standards	
	Effluent discharges. Irrigation and reuse	Fisheries and recreation
<b>Physicochemical properties</b>		
Hg	0.0005 mg/l	0.001 mg/l
As	0.05 mg/l	0.05 mg/l
Pb	0.1 mg/l	0.01 mg/l
Cd	0.01 mg/l	0.005 mg/l
Cr <sub>6+</sub>	0.5 mg/l	0.001 mg/l
Cr <sub>3+</sub>	0.5 mg/l	0.5 mg/l
Ni	0.1 mg/l	0.01 mg/l
Cu	0.01 mg/l	0.001 mg/l
Al	0.2 mg/l	0.2 mg/l
Zn	0.2 mg/l	0.01 mg/l
CN	0.05 mg/l	0.001 mg/l
Phenols	0.25 mg/l	0.001 mg/l
Radioactivity $\Sigma\alpha/\Sigma\beta$	0.1/1.0 Bq/l	0.1/1.0 Bq/l
Total phosphorus	0.025 mg/l	
<b>Biological properties</b>		
Coli index	100 /l	50 /l
Coli count (lactose positive)	5000 /l	20 /l
Caliphas	100 /l	100 /l
Pathogens	ND	

Thermal Mixing Zones: Thermal mixing zones are allowed by NESREA. The zone will be limited to an area not exceeding a quarter of the cross-sectional area. In wide estuaries and oceans, the limits of mixing zones will be established by the agency.

Source: National Environmental (Surface and Groundwater Quality Control) Regulations, 2011

## 2) Effluent standards

The National Environmental (Energy Sector) Regulations 2014 stipulates effluent limitations for power plants as shown below, which is the same as the IFC's EHS guidelines.

**Table 8-1.9 Nigeria's effluent standards for the power sector**

Item	Nigeria's standard	Reference standards	
		Standard	Source
pH	6 – 9	6-9	IFC
TSS	50 mg/l	50 mg/l	IFC
Oil and grease	10 mg/l	10 mg/l	IFC
Total Residue Chlorine	0.2 mg/l	0.2 mg/l	IFC
Iron (Fe)	1.0 mg/l	1.0 mg/l	IFC
Copper	0.5 mg/l	0.5 mg/l	IFC
Lead	0.5 mg/l	0.5 mg/l	IFC
Chromium (total)	0.5 mg/l	0.5 mg/l	IFC
Zn	1.0 mg/l	1.0 mg/l	IFC
Cadmium	0.1 mg/l	0.1 mg/l	IFC
Mercury	0.005 mg/l	0.005 mg/l	IFC
Arsenic	0.5 mg/l	0.5 mg/l	IFC
Temperature increase by thermal discharge from cooling system	±3 deg. C of the ambient temperature of the receiving medium	Depending on the site characteristics	IFC
		±7 C	Japan

Source: National Environmental (Energy Sector) Regulations 2014

IFC, EHS Guidelines for thermal power plants, 2008

### (3) Noise

There are no environmental noise standards in Nigeria, but permissible noise levels from facilities in the general environment are specified as shown below.

**Table 8-1.10 Nigeria's permissible noise levels**

Area, facilities etc.		L <sub>Aeq</sub> (dBA)			
		Permissible level		Reference level (WHO)	
		Daytime	Overnight	Daytime	Overnight
Residential	Any building used as a hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational site	45	35	55	45
	Residential buildings	50	35		
	Mixed residential (with some commercial and entertainment)	55	45		
Residential + industry or small-scale production + commerce		60	50	-	-
Industrial (outside perimeter fence)		70	60	70	70
Construction	Hospital, school, institution of higher learning, homes for the disabled etc.	60	50	-	-
	Buildings other than those prescribed above	75	65		

\*1 The measurement shall be done at the location of the receptors.

\*2 At the receptor, the noise level shall be within the levels or within +3dB of the background level.

Source: National Environmental (Noise Standards and Control) Regulations 2009  
IFC, EHS Guidelines (General EHS guidelines)

#### 8-1-8 Laws and Regulations for Land Acquisition and Involuntary Resettlement

Land acquisition in Nigeria is executed in accordance with the Land Use Act enacted in 1978. According to this law, the land of Nigeria belongs to each state government and a formal certificate of occupancy by state governments allows citizens to hold a lawful interest in the land. For public purposes, land can be expropriated with a governor's approval. Those entitled to land and those who occupy land also have the right to receive compensation. The amount of compensation is determined via land surveys conducted by state governments, based on rents, crops, buildings and equipment. In urban areas, meanwhile, methods of compensation may vary according to state governors or local government jurisdiction, including providing alternative houses. The cost of compensation here is disbursed by a project proponent.

NERC also has issued the Nigerian Electricity Regulatory Commission (Acquisition of Land and Access Rights for Electricity Projects) Regulations stipulating land acquisition and compensation procedures for electricity generation, transmission and distribution projects.

A Preparation of Resettlement Action Plan (RAP) is not required under the Land Use Act but under the NERC regulation. In practice, RAP is often required in the EIA process as an approval condition.

## 8-2 Comparison between JICA Guideline and Nigerian Legislation on the Environmental and Social Consideration

### 8-2-1 EIA Legislation

The contents of EIA legislation in Nigeria are compared with JICA's Environmental and Social Consideration Guidelines (JICA Guidelines). Table 8-2.1 shows how both contents are very similar in terms of category classification in the screening process, contents of the EIA system, reporting items, public participation and public disclosure.

However, the social items for the EIA study do not clearly indicate gender, children's rights, social conflicts in regions and fairness of damage and benefit.

**Table 8-2.1 Comparison between JICA Guidelines and Nigerian legislation related to EIA**

Item	Brief description of Nigerian legislation	Gaps and proposed measures
Category classification	According to the EIA Act and the EIA Procedural Guidelines, all development projects are classified into three categories depending on the degree of potential environmental impacts (extent, nature and location etc.). <ul style="list-style-type: none"> <li>• Category I: A full-scale EIA study is necessary for approval (equivalent to Category A in the JICA Guidelines)</li> <li>• Category II: An IEE-level study is necessary for approval (equivalent to Category B in the JICA Guidelines)</li> <li>• Category III: No EIA or IEE study is necessary for approval</li> </ul> Projects in Sensitive Areas with the following characteristics shall be classified into Category I (EIA Procedural Guidelines 1995):	No significant gaps identified.
Screening	FMEnv conducts screening.	No significant gaps identified.
Scoping and TOR	Project proponents conduct scoping and TOR preparation, which are then reviewed by FMEnv.	No significant gaps identified.
Study items	EIA Guidelines for Power Sector contain the main items which adversely or positively affect environments, depending on the characteristics of power generation and related facilities.	The social items do not clearly indicate gender, children's rights, social conflicts in regions and fairness of damage and benefit. These items must be included as needed.
Contents of the EIA report	Article 4 of the EIA Act states that an environmental impact assessment shall include at least a description of the proposed activities, an assessment of the likely or potential environmental impacts on the proposed activity and the alternatives (including direct or indirect cumulative, short- and long-term effects), an identification and description of measures, an indication of gaps in knowledge and uncertainty which may be encountered in computing the required information, an indication of whether the environment of any other State/Local Government Area or areas outside Nigeria is likely to be affected by the proposed activity or its alternatives and a brief and non-technical summary.	No significant gaps identified.

Item	Brief description of Nigerian legislation	Gaps and proposed measures
Environmental management/monitoring plans	While an environmental management plan is not mentioned in the EIA Act, it is described in the EIA Guidelines for Power Sector. Environmental monitoring is described in Articles 16 and 17 of the EIA Act as a follow-up program and included in the environmental management plan section in the guideline for the power sector. The revised EIA Act (draft) clearly states regarding an environmental management plan.	No significant gaps identified.
Information disclosure and public participation	Although the terms “Stakeholder” or “Public participation” cannot be found in the EIA Act, some descriptions regarding information disclosure and public participation, from the screening stage through the EIA review stage, are mentioned. The revised EIA Act (draft) states the term “stakeholder” which include communities and strengthens information disclosure and public participation such as stakeholder meetings at the scoping stage.	There is no description regarding stakeholders or scoping by project proponents during EIA study. On a project level, information disclosure shall be performed at least twice (at the EIA scoping and DFR stages).
Alternatives	Articles 4 and 17 of the EIA Act are cited regarding alternatives.	No significant gaps identified.

Source: Project Team in reference to EIA Act, Revised EIA Act (draft) and EIA Procedural Guidelines 1999,

### 8-2-2 Land Acquisition/Resettlement Legislation

Comparison between Nigerian laws and regulations related to land acquisition and resettlement (Land Use Act and NERC Regulation) and JICA Guidelines/World Bank’s safeguard policy OP4.12 are summarized in Table 8-2.2. Gaps identified shall be mitigated with appropriate measures at project level to satisfy the World Bank’s safeguard policy.

**Table 8-2.2 Comparison between JICA Guidelines/World bank's Safeguard Policy and Nigerian legislation related to land acquisition and resettlement**

#	JICA guideline/WB OP4.12	Nigerian legislation	Gaps	Proposed measures
1.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA guideline)	• Ownership of movables or real estate shall not be forcibly occupied or redeemed without giving the right to legal proceedings, especially payment of prompt compensation, or allegations to court or judicial jurisdiction. (Constitution Article 44) Where the Commission considers that the project design may entail large-scale adverse social and environmental impacts, the Commission may require the Licensee to explore other alternative project designs. (NERC Regulation).	• There is no corresponding law in Nigeria but there is no big difference with the idea of the Nigerian constitution. However, the policy for unofficial residents is unknown. • There are no policies stated that a Licensee shall preferentially consider avoiding and minimizing resettlement during the planning stage.	• Involuntary resettlement and loss of means of livelihood must be avoided and minimized when feasible by exploring all viable alternatives at an early stage by project proponent. • Any persons who live or earn a livelihood in the target area, including unofficial residents, are considered local stakeholders.
2.	When population displacement is unavoidable, effective measures to minimize the impact and compensate for losses should be taken. (JICA guideline)			
3.	People who must be resettled involuntarily and those whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA guideline)	A licensee shall contain measures to improve the livelihoods and standards of living of the PAPs or at least restore them to pre-displacement levels. (NERC Regulation).	No significant gaps were identified.	Based on the NERC Regulation, livelihood survey for affected people must be conducted before resettlement and monitoring after resettlement to confirm improvements in or at least restore their standard of living.
4.	Compensation must be based on the full replacement cost as much as possible. (JICA guideline)	Compensation cost is assessed on the basis of market values. Depreciation is normally deducted from the compensation cost. (Land Use Act).	Market values with depreciation deducted were lower than requisition values.	Depreciation shall not be deducted from market values, or compensation must be based on the full replacement cost.
5.	Compensation and other kinds of assistance must be provided prior to displacement. (JICA guideline)	Resettlement shall be completed prior to commencement of civil works. Where an offer is accepted, the Licensee shall make full payment of the compensation prior to commencement of civil works. (NERC Regulation).	Timing between compensation payment and physical resettlement is unclear.	Compensation and other kinds of assistance must be provided prior to displacement.

#	JICA guideline/WB OP4.12	Nigerian legislation	Gaps	Proposed measures
6.	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made publicly available. (JICA guideline)	In case of large-scale resettlement, a Licensee shall submit a Resettlement Action Plan to the Commission. (NERC Regulation).	Disclosure of RAP is not stated in the legislation.	RAP must be developed in appropriate language and made publicly available at locations accessible for affected people and local NGOs (such as local government offices).
7.	In preparing a resettlement action plan, the affected people and their communities must be consulted based on sufficient information provided in advance. (JICA guideline)	Not mentioned.	Public consultation is not obliged in the legislation.	Consultations must be held with the affected people and their communities.
8.	When consultations are held, explanations must be given in a form, manner and language that are understandable to the affected people. (JICA guideline)	Not mentioned.	There are no regulations corresponding to this matter.	Depending on characteristics of the ethnic group in community and village, explanations must be given in language and style understandable by the affected people.
9.	Appropriate participation of the affected people must be promoted when planning, implementing and monitoring resettlement action plans. (JICA guideline)	Project Affected Persons (PAPs) shall be consulted and participate in the planning, implementing and monitoring the acquisition and resettlement. (NERC Regulation).	No significant gaps identified.	Participation of affected people must be promoted.
10.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA guideline)	<ul style="list-style-type: none"> <li>• Compensation beneficiaries have the right to appeal to institutions with courts and jurisdiction over the determination of ownership and compensation. (Constitution Article 44)</li> <li>• The Supreme Court has the authority to terminate litigation matters against the compensation amount of the recipients. (Land Use Act) (Land use Act Article 39).</li> </ul>	The right to publicly appeal to the court is stated, but there is no provision for the establishment of a grievance mechanism by the project proponent.	The project proponent sets up a proper and accessible grievance mechanism.
11.	Affected people are to be identified and recorded as early as possible to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para. 6)	Not mentioned.	There are no regulations corresponding to this matter.	Based on WB OP4.12, affected people are to be identified and recorded.

#	JICA guideline/WB OP4.12	Nigerian legislation	Gaps	Proposed measures
12.	Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para. 15)	If land ownership is relinquished for public purposes, the land owner has the right to be compensated. (Land Use Act Article 29).	Nigerian laws and regulations state the right of land owners to receive compensation, but the rights of ownership claims and those without land ownership rights are not stipulated.	Based on WB OP4.12, those who claims ownership without formal legal rights and those who occupy land without landownership are to be compensated.
13.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para. 11)	Not mentioned.	There are no regulations corresponding to this matter.	Based on WB OP4.12, preference is given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
14.	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para. 6)	Not mentioned.	There are no regulations corresponding to this matter. Under the NERC regulation, after the relocation, the livelihood of the PAPs is improved, at least the measures to recover are taken, but support for the transition period is not specified.	Based on WB OP4.12, support for the transition period is provided.
15.	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para. 8)	Not mentioned.	There are no regulations corresponding to this matter.	Base on WB OP4.12, Particular attention must be paid to the needs of the vulnerable groups.
16.	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para. 25)	In case of large-scale resettlement, a Licensee shall submit a Resettlement Action Plan to the Commission. (NERC Regulation).	Although NERC regulation states preparation of RAP for large-scale resettlement, no statement is given for land acquisition and abbreviated RAP.	Based on WB OP4.12, RAP must be prepared abbreviated RAP for land acquisition and small-scale resettlement.

Source: JICA Study Team

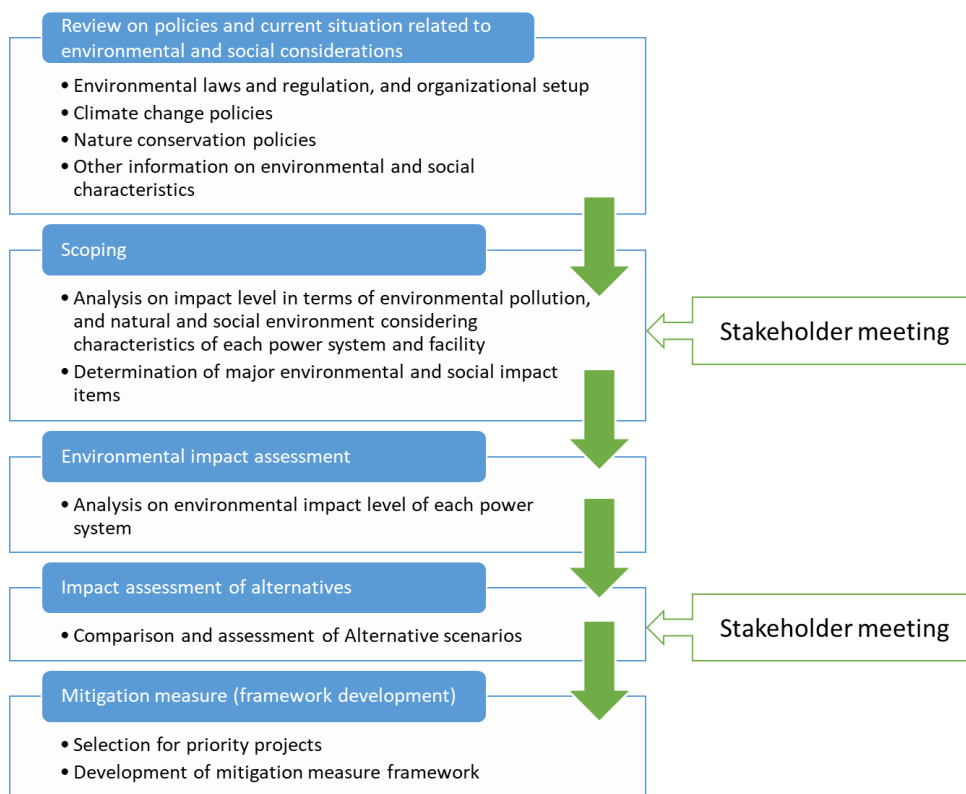
### 8-3 SEA Approach of the Master Plan development

#### (1) Objectives of the Environmental and social consideration

The objectives of the environmental and social consideration at the Master Plan stage (SEA) is to ensure possible environmental and social impacts at the earliest planning stage to consider avoiding or minimizing serious adverse impacts at the individual project planning stage. In this Master Plan planning, based on the SEA concept, it is carried out to identify possible major environmental and social impacts and compare the development scenarios with the environmental and social aspects in mind. It should be noted that EIA, including scoping, is exclusively implemented for each individual project in reference to this SEA result, instead of directly applying the same scoping and assessment result of the SEA.

#### (2) Implementation method

In Nigeria, neither SEA legislation nor procedural guidelines have been established. Accordingly, SEAs carried out in Nigeria by donors and SEAs for power system development in other countries are referred in this Master Plan. The SEA process in this Master Plan is summarized below.



Source: JICA Study Team

**Figure 8-3.1 SEA implementation steps in the Master Plan development**

#### (3) Alternative scenario development

In the Master Plan, based on the power configuration target (Energy Mix Target) of 2030, three alternative scenarios of power development, as described below, are set up in consideration of ongoing



and planned IPP projects and national projects such as hydropower and nuclear power. The scenarios comprise various fuels and power sources in terms of the optimum configuration (refer to Chapter 6-3).

Scenario 1: Scenario based on ongoing and planned IPP projects

Scenario 2: Scenario with a higher percentage of renewable energy than Scenario 1

Scenario 3: Scenario with the highest percentage of renewable energy  
(corresponding to the Energy Mix Target)

In Nigeria, the chronic power shortage, despite remarkable economic growth, should be urgently solved. Meanwhile, as indicated in INDC, sustainable development that takes climate change into consideration is also essential for the power sector, such as introducing renewable energy and improving power generation efficiency. However, solar power cannot be expected as a peak output since daily peak loads occur at night for the time being, hence the crucial need for conventional power systems to secure capacity. Regarding coal-fired power, which is said to emit a large amount of CO<sub>2</sub>, FMEnv recognizes that it is necessary for the moment considering the power situation in Nigeria and is expecting the wide use of domestic coal resources. In fact, coal-fired power was included in the INDC target development and is hence included in the scenarios for the Master Plan development.

Gas-fired power generation remains the mainstream. However, more than half the gas-fired power currently included in the development candidate constitutes simple-cycle gas turbines, which are less efficient compared to combined cycles. Considering the fact that INDC mentions CO<sub>2</sub> reduction by introducing high-efficiency gas thermal power, half the simple cycle power in the development candidate is converted to a combined cycle in each scenario, whereupon six cases are analyzed for the alternative comparison. The difference between scenarios is seen in the ratios of gas-fired (simple- and combined cycle) and renewables, while that of coal-fired, hydro and nuclear is uniform.

**Table 8-3.1 Power development scenarios in 2030**

Configuration	Scenario					
	1		2		3	
	S1-1	S1-2	S2-1	S2-2	S3-1	S3-2
Gas-fired	70%	70%	65%	65%	55%	55%
SC	49%	24%	46%	23%	38%	19%
CC	21%	46%	19%	42%	17%	36%
Renewable	5%	5%	10%	10%	20%	20%
Coal-fired	3%					
Hydro	16%					
Nuclear	6%					

SC: Simple-cycle CC: Combined cycle

\* Scenario 1-2 is the case that 50% of the simple cycle (which occupies 70% of total gas-fired) is converted to the combined cycle. Scenarios 2-2 and 3-2 are set likewise.

\* Coal-fired, hydro and nuclear power configurations are based on ongoing and planned projects, so there is no difference among the scenarios.

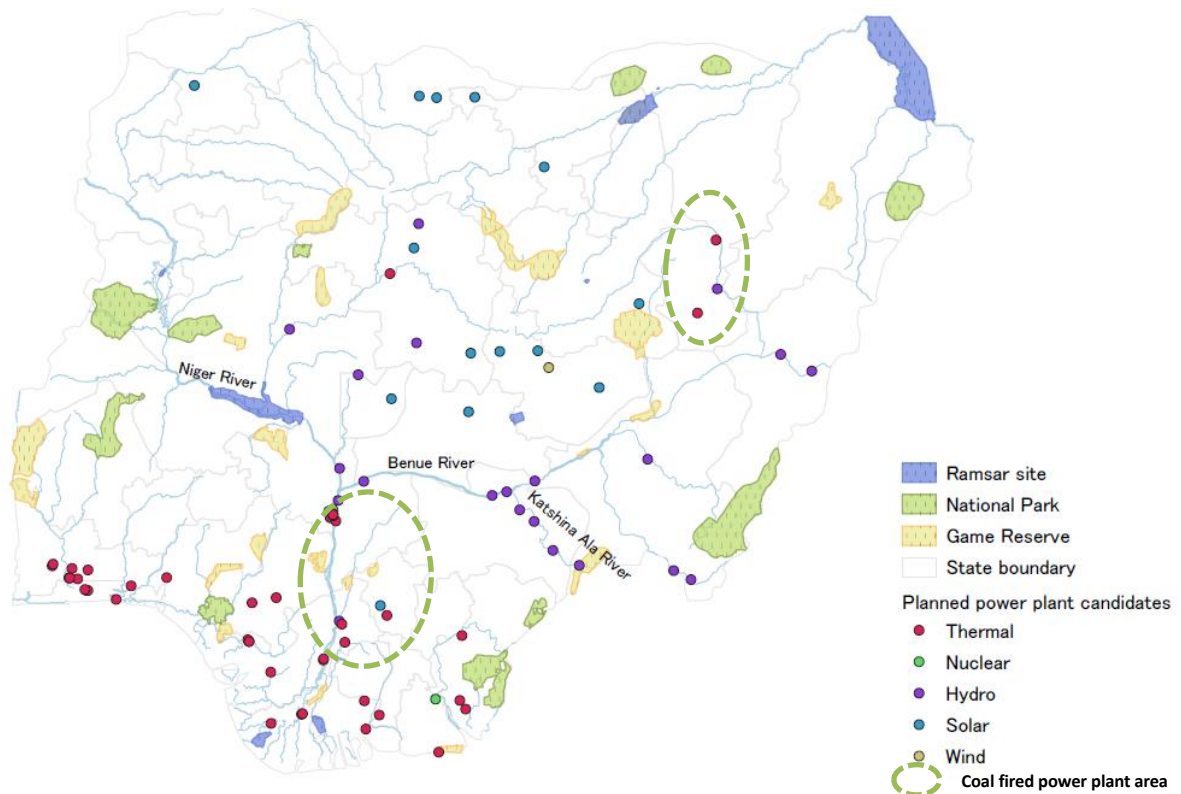
Source: JICA Study Team

## 8-4 Baseline Information on Natural and Social Environment

### 8-4-1 Location of Power Plant Candidates

The locations of planned and ongoing power plants included in the scenarios are shown in Figure 8-4.1. The geographical characteristics of each power system are described as follows:

- Gas-fired: The same as existing gas-fired power plants, located mainly in the southern part of the country, where population and industries are dense. Mostly covered by forests, except urbanized and residential areas.
- Coal-fired: Mostly located in three states (Enugu, Kogi and Gombe), near coal-mining sites.
- Hydro: Mostly located along Niger and Benue rivers in the southeast, densely near the confluence of Niger and Benue rivers and Kashina Ala, the tributary of Benue river.
- Nuclear: Currently two sites planned (Kogi and Akwa Ibom states).
- Wind: One site planned in Plateau state, with its high wind potential.
- Solar: Located in the northern part where solar radiation is high. Categorized in Savanna, except for high-altitude areas.



Source: JICA Study Team

Figure 8-4.1 Location of power plant candidates in the scenarios

## 8-4-2 Natural Environment

### (1) Meteorology

Nigeria is located in tropical lowland and despite the generally high temperature year-round, meteorological conditions differ significantly between the southern part of Nigeria, facing the Gulf of Guinea and the northern part, adjacent to the Sahara desert, due to its vast land area of 923 769 km<sup>2</sup>. In the southern part, it is classified as “Tropical Lowland Rainforest” in Koppen’s climate classification, with many lagoons and dense mangroves along the Gulf coastline. Less precipitation is observed moving toward the north and the climate changes from “Tropical Rainforest” to “Savanna,” then “Semi-arid” near the border with Niger and Chad. Land at an altitude of over 1,500m above sea level, such as Jos Plateau in the eastern part of Nigeria and Adamawa Plateau near the border with Cameroon, is classified as “Highland.”

In Nigeria, rainy and dry seasons can be clearly distinguished; the rainy season continues for 9-12 months in the south and 2-3 months in the north. Peak rainfalls are seen twice (July and September) in the south and once (August) in the north. Based on the 40-year data (1970-2009), the average annual precipitations and temperatures are calculated at 1,150 mm/year and 26.6 deg. C respectively. Annual precipitation ranges from 400mm/year in the northern part to 3,000 mm/year in the Niger Delta area.<sup>5</sup>

### (2) Forests

According to the FAO (Forestry Resources Assessment 2015), the forest area covering Nigeria is 6,990,000 ha, approximately 7.5% of the nation’s land and primary forests rarely exist. Natural forests are observed in the southern region of high rainfall near the Gulf of Guinea and have seriously deteriorated. Table 8-4.1 shows the types of forest vegetation in Nigeria.

**Table 8-4.1 Types of forest vegetation**

Vegetation type	Descriptions
Forest	Generally located in the southern region, with precipitation exceeding 1,150 mm/year. Recently desertification has gradually occurred from the northern part and the forest quality has deteriorated.
Coastal Forest and Mangrove:	Mangroves are observed along the coastline and near estuaries. Because Nigerian mangroves adapt relatively poorly to salt water in general, the mangrove areas are declining.
Deltaic Swamp Forest:	It is distributed on flood plains in large rivers and the Niger Delta. Primitive swamp forest comprises long and thin trees. A secondary swamp forest is being encroached by palm trees.
Moist Lowland Forest:	It is located near the riverbed area along the border with Cameroon, Ondo state and protected forests near Benin.
Forest-Savanna Mosaic:	It is observed in the transition region to Savanna.
Savanna	
Guinea Savanna:	It covers the middle belt of Nigeria. The area with 1,000-1,500 mm/year precipitation has dense vegetation. Depending on vegetation characteristics, it is generally categorized as Savanna Woodland (dense trees and bushes), Shrub Savanna (scattered trees and bushes), Tree Savanna (scattered bushes) and Grass Savanna (no bushes).
Montane:	It is distributed in Jos Plateau with mostly pea family of plants.
Sudan Savanna:	It is located in area with high seasonal rainfall exceeding Guinea Savanna. Spiky bushes are scattered in area with annual precipitation of less than 1,000 mm/year.
Sahel Savanna:	It is observed in area with annual precipitation of less than 500mm/year. Spiky bushes are sparse.

Sources: Japan Overseas Forestry Consultants Association, Forests and forestry in developing countries (2013)

<sup>5</sup> JICA, The project for Review and Update of Nigeria National water Resources Master Plan (2013)

### (3) Protected areas

In Nigeria, although protected areas for biodiversity conservation purpose are set up, conservation activities and management practices are actually inadequate. Consequently, significant deforestation, desertification and soil erosion have become serious problems in some parts of the country. Such environmental deterioration is attributable to deficient scientific data on biodiversity, inadequate coordination between land use policies and the misdistribution of management resources. In addition, local and urban poverty also hinders efforts to promote conservation activities.

Protected areas are classified into the following categories in Nigeria. Some overlap, probably due to inadequate coordination between the relevant federal and state agencies and policies (Table 8-4.2 and Figure 8-4.2).

**Table 8-4.2 Protected areas and important natural habitats**

Protected areas and important natural habitats	Designated area	Summary	Responsible agency	Related regulations etc.
National Parks	Seven areas	National Parks, managed by the FMEnv through National Park Service, comprise areas of ecological and cultural importance where human habitation is not allowed but tourism is encouraged.	National Park Service (FMEnv)	National Park Service Act 2004
Game Reserves	32 areas	Game reserves include Wildlife Parks and Wildlife Sanctuaries established by state governments to protect wildlife. Most are poorly managed.	State Governments	State laws
Forest Reserves	994 areas	Forest reserves are areas designated by state governments to protect timber and other forest resources. Harvesting of timber is allowed under permit and under special concessions to people in the surrounding communities. Harvested timber is mostly replaced with exotic tree species. Most of these forest reserves are also poorly managed. It is reported that in reality, half the designated forest reserves have been withdrawn and turned into agricultural and residential areas <sup>6</sup> .	State Governments	State laws
Biosphere Reserves	One area	There are areas specifically set aside within the forest for scientific and education purposes. No human activities, like tree felling, hunting and firewood collection, are allowed.	Forest Research Institute of Nigeria (FMEnv), State Governments	UNESCO
Ramsar sites	11 areas	Nigeria ratifies the Ramsar Convention and is responsible for promoting conservation of Ramsar sites and ensuring the importance of wetland's ecology, flora and fauna under the convention. There are 11 Ramsar sites in Nigeria and at least eight further sites targeting registration by 2017. The Nigerian government is planning to register four more sites (Chingurme, Ibom/Cross River estuary, Wawan Rafi Wetlands, Akassa coastal wetland) as Ramsar sites.	FMEnv	Ramsar Convention

Source: JICA Study Team based on the National Biodiversity Strategy and Action Plan 2016-2020 and interviews with National Park Service and National Conservation Foundation

<sup>6</sup> FMEnv, National Biodiversity Strategy and Action Plan 2016-2020



IUCN Category	Species	Classification		#	
EN	71	Fauna	<i>Arthropoda</i>	5	
			<i>Chordata</i>	<i>Actinopterygii</i>	12
				<i>Amphibia</i>	4
				<i>Aves</i>	3
				<i>Chondrichthyes</i>	7
				<i>Mammalia</i>	7
		<i>Mollusca</i>	1		
Flora	<i>Tracheophyta</i>	32			
VU	254	Fauna	<i>Arthropoda</i>	7	
			<i>Chordata</i>	<i>Actinopterygii</i>	31
				<i>Amphibia</i>	9
				<i>Aves</i>	14
				<i>Chondrichthyes</i>	15
				<i>Mammalia</i>	18
				<i>Reptilia</i>	8
		<i>Mollusca</i>	2		
Flora	<i>Tracheophyta</i>	150			
TOTAL				359	

CR = Critically Endangered

EN = Endangered

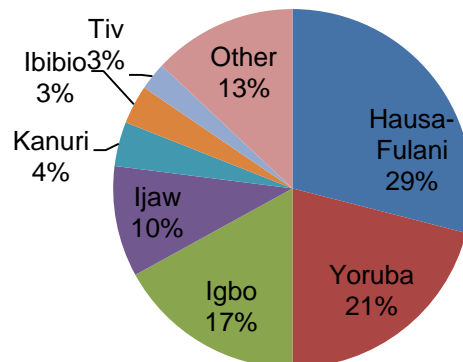
VU = Vulnerable

Source: The IUCN Red List of Threatened Species 2015-4. <http://www.iucnredlist.org/>

### 8-4-3 Social Environment

#### (1) Indigenous peoples

Nigeria has over 250 ethnic groups, with major examples and their population ratios shown in **Figure 8-4.3**. Nigeria was divided into small states after ethnic and religious conflicts continued domestically from long ago, which has seen medium-sized ethnic groups since becoming increasingly influential. Nowadays, serious political conflicts have emerged among states with three big ethnic groups (Hausa, Ivo and Yorba) and mid-size groups taking the lead. Conversely, small indigenous groups are having a hard time between such conflicts.



Source: ILO and ACHPR. The rights of indigenous peoples: Nigeria 2009

**Figure 8-4.3 Major ethnic groups in Nigeria**

According to the report (2009) by ILO and ACHPR<sup>7</sup>, Ogoni, Ijaws and Nmadic Fulanis are identified as indigenous groups based on criteria such as cultural distinctiveness; the extent to which their culture and lifestyle are under threat; dependence on the immediate natural environment; a history of suffering from colonization, discrimination, domination and exploitation; self-identification; and political and social marginalization. The characteristics of these indigenous peoples are described in Table 8-4.4. Other minor groups may also meet these criteria such as Isoko, Urhobo, Itsekiri, Efik and Ibibio in the Niger Delta region. However, given numerous and open-ended criteria for identifying indigenous peoples, Nigeria’s complex ethnic composition does not limit indigenous peoples to such three groups and other ethnic groups may still be identified, depending on location and cultures.

**Table 8-4.4 Characteristics of three indigenous groups**

Indigenous groups	Region	Characteristics
Ogoni	Niger Delta	<ul style="list-style-type: none"> <li>• Agriculture and fishing</li> <li>• Having difficulty in continuing their customary lifestyle and land use due to oil field development</li> </ul>
Nomadic Fulanis	Northern Nigeria	<ul style="list-style-type: none"> <li>• Pastoralist</li> <li>• Migration lifestyle for livestock sparking conflict with other settled ethnic peoples</li> </ul>
Ijaws	Niger Delta	<ul style="list-style-type: none"> <li>• Fishing and aquaculture</li> <li>• The same as Ogoni, having difficulty in continuing their customary lifestyle and land use due to oil field development</li> </ul>

Source: ILO and ACHPR. The rights of indigenous peoples: Nigeria, 2009

## (2) Cultural sites

There are sites revered by local communities for their spiritual, recreational and other socioeconomic attributes, which predominate in the southern parts of the country. Conservation is maintained through superstitions and taboos embedded in traditional belief systems. Major sites are known as following UNESCO World Heritage Sites.

### 1) Cultural Landscape of Sukur (Cultural heritage site registered in 1999)

Sukur is an ancient settlement located in Adamawa Plateau, the southeast region of Nigeria. The Skur tribe with their unique culture lived in the village from the 17th to the early 20th century, engaging in agriculture and iron industry. The remains of many disused iron-smelting furnaces, ritual facilities and the chief’s palaces can still be found.

### 2) Osun-Osogbo Sacred Grove (Cultural heritage site registered in 2005)

Osun-Osogbo Sacred Grove is located within primary forests in in the southern highlands of Nigeria, deemed to be the dwelling place of the Yoruba goddess Osun. The forests also house sanctuaries and temples.

<sup>7</sup> ILO and African Commission on Human and Peoples’ Rights (ACHPR). The rights of indigenous peoples: Nigeria 2009.

#### 8-4-4 EIA Review of Existing Projects

EIA and related documents on two projects, the Zungeru Hydropower plant and the Kaduna power plant, are reviewed to understand implementation practices for environmental and social considerations as supplementary baseline information.

##### (1) Zungeru Hydropower plant

###### 1) Overview

700MW Zungeru Hydropower is located 77km downstream of Shiroro Dam on the Kaduna River. Residential houses are located sparsely in the area and involuntary resettlement is necessary in an area 393km<sup>2</sup> to go underwater. The final version of the EIA report was completed in May 2013 and construction is now ongoing following approval from FMEnv. The EIA report for Zungeru Hydropower development was reviewed here.<sup>8</sup>

###### 2) Natural environment

The project site is situated in the Guinea Savanna band known as a semi-dry area. Desert plants, dry bushes, agricultural fields, plantation and fallows occupy the area and plants grow well along with the river (Figure 8-4.4). Local people recognize wide-ranging species as having religious meanings although none are internationally known and protected. Small animals such as rabbits and birds are found during the site reconnaissance.



**Figure 8-4.4 Dam construction site**

The EIA has analyzed alternatives of the project, including zero option and assessed air quality, noise, surface water and groundwater quality, river sediment, soils and vegetation in the target area during dry and wet seasons.

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<sup>8</sup> Although the EIA report mentions that RAP has separately been developed, it was not provided. Census information of the project-affected persons in 2012 was reviewed here.



### **3) Social environment**

A total of 91 communities<sup>9</sup> in three emirates were confirmed in the planned reservoir area. Regional governance in the area is structured traditionally with an emir at the top of the hierarchy. One household normally comprises 12-18 members, existing as farmers or sometimes cattle breeders. 70% of households have low incomes, less than N5,000 per month. Women, comprising half the regional population, are very good at handcrafting and help sustain their livelihoods, despite very low literacy rates. However, all decision-making is done traditionally by men.

Social infrastructure for water and the sanitary environment has not been fully installed, which results in a high rate of waterborne disease, while no HIV/AIDS patients have been reported in the area. There are several health centers with nurses only and one center with nurses and midwives. Doctors sometimes visit the centers only. Traditional herbal treatments by practitioners are also popular in the region.

### **4) Involuntary resettlement**

22,100 people are to be involuntarily resettled according to related surveys.

### **5) Consultation**

The project recognized people of the emirates, districts, villages and communities in the surrounding area as primary stakeholders and held 97 consultations. In addition, related federal ministries, government agencies and state and local governments as secondary stakeholders, were involved in the project through two public consultations (one each for upstream and downstream areas).

### **6) Impacts and mitigation measures**

Based on the circumstances around the target area and the surveys conducted, the impact assessment was carried out with scoping with an impact matrix and analyzing the cumulative impacts of the project activities. Each impact was selected by scoping, then its measures and impact locations considered. For each influence, the types of impacts and their mitigation measures and places are being considered. Important impact items include soil erosion, loss of ecosystem, river division due to dam construction, remarkable decline in the river flow rate, change in the daily flow rate downstream of the dam and involuntary resettlement.

### **7) Environmental management and monitoring plan**

The environmental management and monitoring plan sets out the roles and responsibilities of the project proponent and the framework of the environmental management and monitoring. To implement the plan, the project will set up an environmental management unit to manage environmental aspects, including supervision of contractors.

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<sup>9</sup> It became 98 communities later, according to newspaper information.

## 8) Issues on the environmental and social consideration

According to information from local media and project-related documents, several concerns have emerged in terms of environmental and social considerations.

### ■ Compensation to affected people

Surveys for the project have shown that 22,100 people need to be resettled and 15,958 agricultural plots and 6,762 assets will be affected. FMP established the Zungeru Hydropower residential committee to coordinate compensation from 2014. However, the construction proceeded without proper compensation payment. The federal government finally started disbursement to nearby residents from March 2017 in accordance with the state's survey, the amount of which is expected to exceed 1 billion Naira.

### ■ Impacts during construction (information disclosed to residents)

According to newspaper reports, land reclamation at private property and blasting started without the affected people getting any notice, resulting in noise and dust pollution.

### ■ Delay to construction work

The construction work has been frequently delayed since 2013 when a Chinese company resumed, due to obstructions by residents who haven't received any compensation, financial problems and lawsuits for breach of contract.

## (2) Kaduna power plant

### 1) Overview

The 215MW Kaduna power generation project involves constructing a dual-fired (gas and oil) power plant, located in the Kaduna Industrial Area in Kaduna state. The project site comprises 28,167 ha and power generated will be connected to a transmission line 8km from the site and to the power grid. The power plant will run on LPFO until the gas supply infrastructure to the site is constructed. Before the plant starts up, the following activities are conducted:

- Land acquisition (executed by the Kaduna state Government)
- Land reclamation
- Construction of the access road
- Construction of power generation facilities and ancillary equipment
- Involuntary resettlement and compensation to affected people

A draft EIA report of the project was issued in April 2015. The approval process of EIA was once briefly suspended, but proceeded with the draft EIA disclosure to public for 21 days by the end of 2016 and a panel review by FMEnv is planned in February 2017. Fuel gas will be supplied via a nearby gas pipeline in future. The EIA of the pipeline is not included in this project EIA and will be prepared separately.

## **2) Natural environment**

The project is located in the Guinea Savanna band, with high temperature and low humidity. The surrounding area comprises water bodies and encompasses various land use such as agriculture and semi-agricultural land, dense vegetation and residential area. Alternative analysis, including zero options as well as various kinds of surveys such as air quality, noise, surface water and groundwater, river sediment, soil and ecosystem were seasonally studied in EIA.

## **3) Social environment**

Regional governance in the area is structured traditionally with an emir at the top of the hierarchy. The local youth association mainly oversees sanitary management and regional projects and vigilance. In EIA, a socioeconomic survey was conducted at four communities around the site in Chikun LGA. One tribal group lives in the region where half the people earn N100,000-500,000 per year and 40% N10,000-N100,000 per year. The literacy rate is high, exceeding 80%. Popular jobs include farmers, housewives, fishermen, public officers, technicians, daily laborers and small business traders. People mostly utilize groundwater for domestic use.

## **4) Involuntary resettlement**

The project site is located in an industrial zone, acquired by Kaduna state from 2009 to 2010 and subsequently transferred to the federal government. However, it was revealed during the EIA study that the state government had yet to complete the compensation payment, according to some of the land owners. EIA subsequently recommended that FMPWH review documents proving the compensation payment made by the state and develop a resettlement framework to apply any resettlement activities.

## **5) Public consultation**

Public consultations have been conducted for local residents and related government authorities as part of the socioeconomic survey based on the Nigerian regulation.

## **6) Impacts and mitigation measures**

Based on the circumstances around the target area and the surveys conducted, an impact assessment was carried out with scoping by an impact matrix and analyzing the cumulative impacts caused by project activities. Each impact was selected by scoping, with its measures and impact locations considered, including impact analysis on gas emissions with dispersion modeling).

## **7) Environmental management and monitoring plan**

The environmental management plan includes environmental management guidelines, audit procedures, environmental management plan, monitoring plan, organizational structure and their roles, responsibilities and training.

## **8) Issues on environmental and social considerations**

### ■ Resettlement procedure and compensation

It is not known how involuntary resettlement and land acquisition were executed although it is handled by the state government, due to the lack of RAP preparation. Besides, the compensation payment procedure and its execution status remains unclear considering the fact that the land owners complained about incomplete payment.

### ■ Environmental and social considerations on related (inseparable) projects

In addition to this project, two other inseparable projects, construction of an 8km transmission line and 14km gas pipeline, have been planned. Since both are outside the project EIA scope, EIAs must be separately prepared and approved.

## **(3) Summary**

After reviewing the EIA documents in the power sector, it emerged that both projects were delayed due to the problem in acquiring land. Accordingly, the following issues should be carefully considered to proceed with individual projects:

### **1) Land acquisition and resettlement procedure and compensation**

In Nigeria, resettlement and land acquisition is basically executed by state governments for public purposes. Consequently, state governments should coordinate with project proponents, while the proponents should understand the activity status well. It is also important to prepare RAP as well as official compensation documents.

### **2) Communication with affected people and workers**

In addition to consultations and meetings with those affected by land acquisition and resettlement, a project should communicate thoroughly with those affected by construction works to ensure they understand the project activities well. Traditional customs mostly dominate local governance in rural area with women having less influence. Accordingly, gender equality in project participation should be taken into account. To facilitate implementation, it is also advisable to explain the project activities to workers to ensure their proper understanding.

### **3) Environmental and social considerations on related project (inseparable project)**

It is recommended that project proponents for power plant construction review the environmental and social considerations of related inseparable projects such as transmission lines and gas pipelines as far as possible and request proper implementation from other parties as needed.

## 8-5 SEA Implementation

### 8-5-1 Scoping

#### (1) Environmental item screening

In reference to the JICA Guidelines (Environmental Checklist), potential environmental and social impact significances associated with each power generation facility and transmission developments are classified for the alternative scenario analysis in terms of environmental and social considerations. Power generation types include fossil fuel (gas and coal), hydropower, nuclear power and renewable energy sources (solar and wind).

**Table 8-5.1 Potential impact significance of the power system development**

Item	Fossil fuel power		Hydro	Nuclear	Renewable energy		Transmission
	Gas	Coal			Wind	Solar	
<b>1. Environmental pollution</b>							
Air quality	B-	A-/B-	D	D	D	D	D
Water quality	A-/B-	A-/B-	A-/B-	A-/B-	D	D	D
Waste	B-	A-/B-	B-	B-	D	B-	D
Soil contamination	D	B-	D	B-	D	D	D
Noise and vibration	A-/B-	A-/B-	D	A-/B-	B-	D	D
Ground subsidence	C	C	C	C	C	C	C
Odor	D	D	D	D	D	D	D
Bottom sediment	D	D	B-	D	D	D	D
<b>2. Natural environment</b>							
Protected areas	B-/D	B-/D	B-/D	B-/D	B-/D	B-/D	B-/D
Ecosystem	B-/D	B-/D	A-/B-	B-/D	B-/D	B-/D	B-/D
Hydrology	B-	B-	A-/B-	B-	D	D	D
Topography and geology	B-/D	B-/D	A-/B-	B-/D	D	D	D
<b>3. Social environment</b>							
Resettlement	B-	B-	A-/B-	B-	B-	B-	B-
Poverty	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-
Ethnic Minorities and Indigenous People	C	C	C	C	C	C	C
Regional economy (job opportunities and livelihood)	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-	B+/-
Land Use and Natural Resources	B-/D	B-/D	A-/B-	B-/D	B-/D	B-/D	B-
Water Use	B-/D	B-/D	A-/B-	B-/D	B-/D	B-/D	D
Existing Social Infrastructure and Institution	B-/D	B-/D	A-/B-	B-/D	B-/D	B-/D	B-
Misdistribution of Benefit and Damage	B-	B-	B-	B-	B-	B-	B-
Local Conflict of Interest	B-	B-	B-	B-	B-	B-	B-/D
Cultural heritage	B-/D	B-/D	B-/D	B-/D	B-/D	B-/D	B-/D
Landscape	B-	B-	B-	B-	B-	B-	B-
Gender/Children's right	B+/D	B+/D	B+/D	B+/D	B+/D	B+/D	B+/D
HIV/AIDS and diseases	B-	B-	B-	B-	B-	B-	B-
Working environment	B-	B-	B-	B-	B-	B-	B-
<b>4. Other</b>							
Accidents	B-	B-	B-	A-/B-	B-	B-	B-
Electromagnetic waves	D	D	D	D	D	D	B-
Climate change	B-	A-/B-	C	D	D	D	D

A+/-: Significant positive/negative impact

B+/-: Positive/negative impact to some extent

C: Positive/negative impact unknown

D: No impact

Source: JICA Study Team and TWG (ESC)

At this stage of the Master Plan, it is difficult to evaluate these impacts rigorously and uniformly because the details of each project are not fixed and the spatial and time range is diverse. Accordingly, the impacts on each facility are estimated based on regional environmental and social characteristics, general system specification and discussion in TWG.

Nigeria has started discussing nuclear power development in line with national policy. This Master Plan thus considers nuclear power as one of the power generation types. If any nuclear-related accident were to occur, it would cause catastrophic environmental and social harm due to radioactive substances. The safety of nuclear power is key to executing the project and needs to be thoroughly discussed from a technical perspective for a long period. With such special circumstances in mind and the characteristics of nuclear power, impacts on radioactive substances are excluded in principle here at the Master Plan stage and instead taken into consideration at the individual project stage with a more detailed project design.

**(2) Determination of major environmental and social impact items**

Major environmental and social items and subsequent evaluation indicators are determined based on the impacts of each power system in the screening described above. Potentially important items include 21 items for power generation (six in pollution control, four in the natural environment, nine in the social environment and two in other categories) and 12 for transmission development (two in the natural environment, nine in the social environment and one in another category).

**Table 8-5.2 Important environmental items and evaluation indicators (power generation)**

Items		Major impacts	Evaluation indicators
Pollution control	Air quality	<ul style="list-style-type: none"> <li>Air pollution caused by exhaust gas (NOx, Sox and SPM)</li> </ul>	<ul style="list-style-type: none"> <li>Air pollutant emission from facility</li> </ul>
	Water quality	<ul style="list-style-type: none"> <li>Water pollution caused by discharged water (pH, TSS, residual chlorine, oil, heavy metals etc.)</li> <li>Temperature change in water body caused by thermal water discharge</li> </ul>	<ul style="list-style-type: none"> <li>Water pollutant discharge from facility</li> <li>Thermal water discharge</li> </ul>
	Waste	<ul style="list-style-type: none"> <li>Solid waste and industrial waste generation</li> <li>Coal ash and radioactive waste generation</li> <li>Used solar panel and battery disposal</li> </ul>	<ul style="list-style-type: none"> <li>Amount of waste generation and their treatment methods</li> </ul>
	Soil contamination	<ul style="list-style-type: none"> <li>Soil contamination caused by pollutants (heavy metals and VOC)</li> </ul>	<ul style="list-style-type: none"> <li>Pollutant release on the ground</li> </ul>
	Noise and vibration	<ul style="list-style-type: none"> <li>Noise and vibration from machines</li> <li>Low frequency noise pollution</li> </ul>	<ul style="list-style-type: none"> <li>Generation of noise and vibration</li> </ul>
	Bottom sediment	<ul style="list-style-type: none"> <li>Environment degradation of bottom sediment in water body (river, lakes, dam reservoir and sea) caused by soil erosion and wastewater discharge</li> </ul>	<ul style="list-style-type: none"> <li>Water quality in water body</li> <li>Environmental quality of bottom sediment</li> </ul>
Natural environment	Protected areas	<ul style="list-style-type: none"> <li>Degradation of protected area environment caused by project (dividing protected area, restriction of animal movements etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on protected area</li> </ul>
	Ecosystem	<ul style="list-style-type: none"> <li>Habitat loss of vulnerable species caused by land reclamation and river flow change</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on the habitat of vulnerable species</li> </ul>
	Hydrology	<ul style="list-style-type: none"> <li>River flow decrease in upstream and downstream of dam reservoir</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on water catchment environment</li> </ul>

Items		Major impacts	Evaluation indicators
		<ul style="list-style-type: none"> <li>Environmental change of water catchment</li> <li>Reduction and drying up of groundwater</li> </ul>	
	Topography and geology	<ul style="list-style-type: none"> <li>Land reclamation caused by projects (cutting and filling)</li> <li>Erosion soil and sediment flow-in</li> </ul>	<ul style="list-style-type: none"> <li>Topographical change of the project site and neighboring area</li> </ul>
Social environment	Resettlement	<ul style="list-style-type: none"> <li>Involuntary resettlement</li> <li>Land acquisition</li> </ul>	<ul style="list-style-type: none"> <li>Scale of land acquisition and resettlement</li> </ul>
	Land and regional resource use	<ul style="list-style-type: none"> <li>Access restrictions on agricultural land, hunting area and forests</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on land and regional resource use</li> </ul>
	Water use	<ul style="list-style-type: none"> <li>Access restrictions on water use such as groundwater and river</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on water use</li> </ul>
	Existing social infrastructure and services	<ul style="list-style-type: none"> <li>Access restrictions on infrastructure such as roads</li> <li>Access restrictions on hospital and tap water</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on existing infrastructure and services</li> </ul>
	Uneven distribution of damages and benefits	<ul style="list-style-type: none"> <li>Uneven distribution of damages and benefits caused by project activities (uneven community support provided by the project proponent etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Occurrence on uneven distribution of damages and benefits</li> </ul>
	Conflict of interest in the region	<ul style="list-style-type: none"> <li>Conflict of interest in the region caused by project activities (dissatisfaction due to benefits distributed unfairly among communities)</li> </ul>	<ul style="list-style-type: none"> <li>Occurrence on conflict of interest in the region</li> </ul>
	Heritage	<ul style="list-style-type: none"> <li>Relocation and access restrictions on cultural heritage</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on cultural heritage</li> </ul>
	Landscape	<ul style="list-style-type: none"> <li>Landscape change caused by the project facility construction</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on landscape</li> </ul>
	HIV/AIDS and infectious diseases	<ul style="list-style-type: none"> <li>Increase in infectious diseases caused by project worker inflow</li> </ul>	<ul style="list-style-type: none"> <li>Efforts on health and sanitation</li> </ul>
	Working conditions	<ul style="list-style-type: none"> <li>Accidents and health damage on project workers</li> </ul>	<ul style="list-style-type: none"> <li>Efforts on occupational health and safety</li> </ul>
Other	Accidents	<ul style="list-style-type: none"> <li>Impacts on surrounding natural and social environment caused by severe accident</li> </ul>	<ul style="list-style-type: none"> <li>Measures on severe accidents</li> </ul>
	Climate change	<ul style="list-style-type: none"> <li>Greenhouse gas emissions</li> </ul>	<ul style="list-style-type: none"> <li>CO<sub>2</sub> emission from projects</li> </ul>

Source: JICA Study Team

**Table 8-5.3 Important environmental items and evaluation indicators (Transmission line)**

Items		Major impacts	Evaluation indicators
Natural environment	Protected areas	<ul style="list-style-type: none"> <li>Degradation of protected area environment caused by project (dividing protected area, restriction of animal movement etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on protected area</li> </ul>
	Ecosystem	<ul style="list-style-type: none"> <li>Habitat loss of vulnerable species caused by land reclamation and river flow change</li> <li>Bird strike</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on habitat of vulnerable species</li> </ul>
Social environment	Resettlement	<ul style="list-style-type: none"> <li>Involuntary resettlement and land acquisition on ROW</li> </ul>	<ul style="list-style-type: none"> <li>Scale of land acquisition and resettlement</li> </ul>
	Land and regional resource use	<ul style="list-style-type: none"> <li>Access restrictions on agricultural land, hunting area and forests</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on land and regional resource use</li> </ul>
	Existing social infrastructure and services	<ul style="list-style-type: none"> <li>Access restrictions on infrastructure such as roads</li> <li>Access restrictions on hospital and tap water</li> </ul>	<ul style="list-style-type: none"> <li>Impact severity on existing infrastructure and services</li> </ul>
	Uneven distribution of	<ul style="list-style-type: none"> <li>Uneven distribution of damages and benefits caused by project activities (uneven</li> </ul>	<ul style="list-style-type: none"> <li>Occurrence on uneven distribution of damages and benefits</li> </ul>

Items		Major impacts	Evaluation indicators
	damages and benefits	community support provided by the project proponent etc.)	
	Conflict of interest in the region	• Conflict of interest in the region caused by project activities (dissatisfaction due to benefits distributed unfairly among communities)	• Occurrence on conflict of interest in the region
	Heritage	• Relocation and access restrictions on cultural heritage	• Impact severity on cultural heritage
	Landscape	• Landscape change caused by lattice towers	• Impact severity on landscape
	HIV/AIDS and infectious diseases	• Increase in infectious diseases caused by project worker inflow	• Efforts on health and sanitation
	Working conditions	• Accidents and health damage on project workers	• Efforts on occupational health and safety
Other	Accidents	• Impacts on surrounding natural and social environment caused by severe accident	• Measures on severe accidents

Source: JICA Study Team

### 8-5-2 Environmental Impact Assessment

For the important impact items and evaluation indicators identified in (1), IEE is implemented for each power supply system so that the cumulative impact in each scenario is thoroughly evaluated based on the result. Since the details of individual projects are unknown at the Master Plan stage, the IEE considers the effects of introducing mitigation measures, based on the current situation in Nigeria and general practices at the time of implementing the project.

Evaluation of each item is converted to points on the scale below and the sum of points divided by the maximum (= 63 points) is used to determine the impact of the corresponding power generation. “Climate change” is excluded because CO<sub>2</sub> emissions are separately evaluated in the scenario comparison (refer to Chapter 6-3).

- 3: Large negative impact expected (very hard to avoid even with mitigation measures)
- 2: Moderate negative impact expected (scope to mitigate with appropriate measures)
- 1: Low negative impact expected
- 0: No negative impact expected

**Table 8-5.4 Environmental impact assessment on power system development**

Item	Fossil fuel power		Hydro	Nuclear	Renewable energy		Note
	Gas	Gas			Wind	Solar	
<b>1. Environmental pollution</b>							
Air quality	2	2	0	0	0	0	Exhaust gas is emitted by fossil fuel combustion, but can be mitigated with technical measures.
Water quality	2	2	2	2	0	0	Pollutant release in wastewater can be reduced with technical measures.
Waste	2	3	2	3	0	2	Coal ash is generated by coal combustion and radioactive waste by nuclear reaction. Used solar panel and battery disposal required for renewal. Other



Item	Fossil fuel power		Hydro	Nuclear	Renewable energy		Note
	Gas	Gas			Wind	Solar	
							waste is mainly solid and industrial waste.
Soil contamination	0	2	0	2	0	0	Soil contamination caused by fuels may occur, but can be avoided with mitigation measures.
Noise and vibration	2	2	0	2	2	0	It can be mitigated by installing equipment with covers, selecting proper locations etc.
Bottom sediment	0	0	2	0	0	0	It can be mitigated by improving inflow water.
<b>2. Natural environment</b>							
Protected areas	1	1	2	1	1	1	Mitigation is possible by considering the project location. The footprint of hydropower is relatively large and its impact significant, exceeding that of other power systems.
Ecosystem	2	2	3	2	2	2	Mitigation may reduce impacts with measures. The footprint of hydropower is relatively large and its impact significant, exceeding that of other power systems.
Hydrology	2	2	3	2	0	0	Hydrology may be affected by thermal water discharge from fossil fuel power and nuclear power, but can be mitigated by selecting discharge points. Hydropower causes major changes to the water flow.
Topography and geology	2	2	3	2	0	0	Mitigation is possible by selecting the site for fossil fuel and nuclear power. Hydropower causes large topographical change.
<b>3. Social environment</b>							
Resettlement	2	2	3	2	2	2	Impact on the affected people can be reduced with mitigation measures based on RAP. Hydropower development causes relatively large-scale resettlement.
Land Use and Natural Resources	2	2	2	2	2	2	Although land use and natural resources are access-limited, may be mitigated by providing alternative sites.
Water Use	1	1	2	1	1	1	Although water use is access-limited, its impact is relatively low. Hydropower affects downstream water use, but may be mitigated by maintaining flow.
Existing Social Infrastructure and Institution	1	1	1	1	1	1	Access to existing social infrastructure and institutions may be affected, but its impact is low by providing alternatives.
Misdistribution of Benefit and Damage	1	1	1	1	1	1	Its impact is low with fair distribution planning.
Local Conflict of Interest	1	1	1	1	1	1	Its impact is low with fair distribution planning.
Cultural heritage	1	1	1	1	1	1	Its impact is low with giving consideration on site location.
Landscape	2	2	2	2	2	2	Landscape may change largely with facility implementation but may be mitigated by proper design and location.

Item	Fossil fuel power		Hydro	Nuclear	Renewable energy		Note
	Gas	Gas			Wind	Solar	
HIV/AIDS and diseases	1	1	1	1	1	1	Its impact is low on health if sanitation training is provided for residents and workers.
Working environment	1	1	1	1	1	1	Its impact is low if occupational safety training is provided.
<b>4. Other</b>							
Accidents	2	2	2	2	2	2	Accidents including fuel spill, explosion and facility collapse etc. may be mitigated with proper safety measures.
Total	0.48	0.52	0.54	0.49	0.32	0.32	

Source: JICA Study Team

The magnitude of the environmental impact potential by each power system is (1) hydropower, (2) coal-fired power, (3) nuclear power, (4) gas-fired power, (5) wind power and solar power in order. Major factors in this result are the fact that hydropower affects the natural environment significantly and unavoidably due to its large footprint and that coal-fired power generates coal ash in bulk.

“Waste,” “Hydrology,” “Topography and geology,” and “Resettlement” are considered the key environmental impact items, the assessment results and mitigation measures of which are summarized as follows:

### 1) Waste

In the power generation business, coal ash from coal-fired power plants is the most discharged form of waste among other solid waste. Coal ash contains a small amount of heavy metals, hence the need to store and treat the ash properly to prevent pollutant elution and prevent the dust from scattering. In Japan, 97% of coal ash from power plants is recycled as raw materials for cement and pavement blocks. Since it is unlikely that such recycling projects exist in Nigeria, it is recommended that project proponents with FMEnv and other related parties be promoted at the earliest possible stage, led by the Government of Nigeria.

From a nuclear power generation perspective, disposal of spent nuclear fuel is crucial. In Japan, nuclear power generation has been carried out since the 1960s and now spent nuclear fuel is reprocessed promoting nuclear fuel recycling. However, due to delays and accidents in plant construction, reprocessing remains insufficient and safety management has yet to be secured for storing the fuel and finally disposing of high-level radioactive waste. In future, when nuclear power generation is promoted in Nigeria, it is likely to be impossible to introduce radioactive waste unless consideration is given from the early stage to disposing of the same.

### 2) Ecosystem

Hydropower, which includes relatively large area development, has the biggest impact among other power systems. Hydropower candidates in the pipeline are located densely on the Niger, Benue and Kassarina Ala rivers; all of which are in southeast Nigeria. Tropical rainforests and mangroves spreading

toward the south have relatively rich forest ecosystems. Installing hydropower and the emergence of dam reservoirs may cause various impacts such as a decline in forested areas, loss of habitat for vulnerable species and restrictions on animal movement. It is important to mitigate such impacts for the natural environment by adopting a technical design (selecting a run-of-river type etc.).

### **3) Hydrology**

Due to the installation of hydropower reducing the volume of water and changing the velocity at which the river flows, significant impacts are felt within the entire water basin, not only downstream and upstream but also the groundwater flow. Mitigation measures have to be taken based on proper surveys as part of each project planning process, such as maintaining flow volume. Fossil fuel power and sites require significant cooling water, which is why such facilities are constructed on shorelines and close to rivers. Although impacts of thermal water are also felt, these can be mitigated to implement proper measures such as selecting discharge points.

### **4) Topography and geology**

In hydroelectric power generation, extensive land development is necessary and large-scale land modification is carried out by blasting etc. There are also concerns about the impacts of sediment inflow into upstream/downstream areas, riverbed change and soil erosion and volume. It is essential to conduct adequate investigation and examination in individual project implementation and take measures accordingly.

### **5) Resettlement**

Hydropower candidates are located in Lokoja, Kogi states (population of approx. 200,000), at the confluence of the Niger and Benue rivers and their downstream candidate sites are located in the major cities of Asaba and Onicha (collective population of 400,000). There are also cities with 200,000 people at the junction of Benue and Catshina Ala rivers. It is likely that these hydropower developments would result in large-scale resettlement and land acquisition. In areas for other candidates, many agricultural fields are observed, hence the need for proper consideration on restoring the livelihood of surrounding residents. For individual projects, not only for hydropower, it is important to thoroughly study alternatives that can minimize resident relocations and the impacts on affected people and formulate and implement a resettlement action plan.

#### **8-5-3 Impact Analysis of Alternative Scenarios**

Each scenario is scored in terms of total cost, the need for system stabilization measures, CO<sub>2</sub> emissions and environmental and social impacts, with a maximum of three points in each category and the total scores of the scenarios are compared.

1. Total cost by 2040: Score three points for the lowest cost scenario.
2. The need for system stabilization measures due to renewable energy connection: Score three points when no measures required and 1.5 points when they are necessary.

3. CO<sub>2</sub> emissions by 2040: Score three points for the lowest CO<sub>2</sub> emissions scenario.
4. Environmental and social impact (except climate change): Multiply the impact indices of each power system (gas: 0.51, Coal: 0.52, Hydro: 0.54, Nuclear 0.49, Win: 0.32, Solar: 0.32) with the system configuration percentage of each scenario and add them up scenario-wise. Score three points for the lowest number (= minimum impact case).

**Table 8-5.5 Scenario alternatives comparison (with environmental and social considerations)**

Category	Scenario					
	S1-1	S1-2	S2-1	S2-2	S3-1	S3-2
1 Total cost by 2040 (Million USD)	204,556	204,556	210,315	210,315	214,646	214,646
Point	3.0	3.0	2.0	2.0	1.0	1.0
2 Need for system stabilization measures due to renewable energy connection	No	No	Yes	Yes	Yes	Yes
Point	3.0	3.0	1.5	1.5	1.5	1.5
3 CO <sub>2</sub> emission by 2040 (Million t)	1,008	907.2	1,002	901.8	957	861.3
Point	0.5	2.0	1.0	2.5	1.5	3.0
4 Environmental and social impact (except climate change)	0.48	0.48	0.47	0.47	0.45	0.45
Point	1.0	1.0	2.0	2.0	3.0	3.0
Point total	7.5	<b>9.0</b>	6.5	8	7	8.5

Based on the abovementioned six scenario comparisons, S1-2 receives the highest points score. Although S1-2 has the lowest environmental and social impact due to the low percentage of renewable power, installing a combined-cycle gas-fired system paves the way for a scenario of fewer CO<sub>2</sub> emissions at the lowest cost. Scenario 1 includes power generation projects involving gas-fired, coal-fired, hydro, nuclear and renewable energy (solar and wind). The preferred scenario involves converting half the simple-cycle gas-fired plants to the combined cycle in Scenario 1.

In Nigeria, INDC targets 13GW of off-grid solar power by 2030 and NPCC has introduced at least 20% renewable energy by 2030. When 13GW off-grid solar power is installed by 2030, the total generating capacity would become 67,927MW (on- and off-grid) in case of S1-2. Considering that 5% of S1-2 (2,746MW) is renewable energy, approximately 23% of electricity (15,746MW) in Nigeria would be generated by renewable energy. Accordingly, even in the case of Scenario 1, the lowest renewable energy case, the target stated in NPCC would be achievable. In addition, INDC cites “Efficient gas generators” as one of the key measures to tackle the GHG reduction. S1-2 therefore sounds reasonable to secure the necessary power demand alongside work to promote the combined cycle, rather than the simple cycle, to boost efficiency and reduce GHG emissions.

However, combined-cycle gas-fired plants are not popular in Nigeria due to the high investment costs compared to the simple-cycle equivalents. Besides, coal-fired gas plants, configuring 3% of each scenario, require proper environmental measures to handle air pollution and GHG emissions such as desulfurization, denitrification, bug filter and low-NOx burner. Moving forward, it is vital to develop an implementation strategy at the federal level to give IPP incentives to install the combined cycle, or high-efficiency and

environmentally sound coal-fired plants. There may be various kinds of methodologies and conditions for such incentives, such as direct regulations, subsidies, environmental tax and emission trading. The federal government should start such discussions urgently, with international and national practices in mind.

#### **8-5-4 Mitigation Measures**

The preferred scenario selected in 8-5-3 targets CO<sub>2</sub> reduction with an efficient gas-fired system, so priority power generation projects are apparently gas-fired. However, specific projects cannot be chosen at this stage due to Nigeria's decision that thermal power will be further fully developed by the private sector. In addition, the transmission development plan includes various rehabilitation and new installation of transmission lines based on technical analysis with the power generation scenario, but individual routes of the lines have not been discussed at this stage. In this Master Plan, the framework of the survey contents, mitigation measures and monitoring from environmental and social considerations is developed for a gas-fired power plant and a transmission line in general, in accordance with key environmental items based on scoping described in 8-5-1 (from Table 8-5.6 to Table 8-5.9). It is essential for an individual project to fully perform EIA considering the project's unique characteristics and referencing this framework.

**Table 8-5.6 Important impact items and mitigation measures (framework) for gas-fired power generation**

Item	Survey target	Analysis methods	Mitigation measures
Alternative comparison	<ul style="list-style-type: none"> <li>Alternative assessment (especially “zero option” and location)</li> </ul>	<ul style="list-style-type: none"> <li>Alternative project comparison including zero option</li> <li>Project site alternative comparison                             <ul style="list-style-type: none"> <li>✓ Comparison of the number of affected people to be resettled (approximation) caused by the project construction</li> <li>✓ Comparison of distances from important ecosystems and protected areas</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>By comparing alternatives, adopt a proposal that has less impact on the environment and society, such as a plan with less resident relocation and less impact on important ecosystems/protected areas</li> </ul>
<b>Environmental pollution</b>			
Air quality	<ul style="list-style-type: none"> <li>Impact on air quality caused by vehicle movement during construction</li> <li>Impact on air quality caused by pollutant emission (especially NOx from stacks) during operation</li> </ul>	<ul style="list-style-type: none"> <li>Present air quality survey in the area in which the project is located (baseline survey with sampling)</li> <li>Traffic volume and route forecast during construction</li> <li>Prediction of pollutants emitted from the power plant and their sources and emission volumes</li> <li>Dispersion prediction of NOx emitted from stacks (numerical dispersion modeling) and comparison with criteria (Nigerian standards and international standards such as WB’s)</li> </ul>	<ul style="list-style-type: none"> <li>Proper management of construction vehicles</li> <li>Installation of low-NOx burner and denitrification equipment</li> <li>Installation of emission gas monitoring device at stack</li> <li>Securing stacks of appropriate height during planning</li> </ul>
Water quality	<ul style="list-style-type: none"> <li>Impact by turbid water during construction</li> <li>Impact by wastewater</li> <li>Impact by hot water discharge (when water cooling system employed)</li> </ul>	<ul style="list-style-type: none"> <li>Present water quality survey in the area in which the project is located (baseline survey with sampling)</li> <li>Prediction of wastewater types and discharge volumes</li> <li>Survey on the discharge points and discharge methods</li> <li>Comparison between expected wastewater discharge quality and criteria (Nigerian standards and international standards such as WBs)</li> <li>Thermal dispersion prediction of hot water discharge (numerical dispersion modeling) and comparison with criteria (Nigerian standards and international standards such as WB’s)</li> <li>Analysis of impact on aquatic habitats caused by wastewater discharge</li> </ul>	<ul style="list-style-type: none"> <li>Installation of a silt fence to prevent turbid water dispersion</li> <li>Installation of wastewater treatment equipment such as oil-water separator, septic tanks and neutralization device</li> <li>Regular water quality modeling of discharge around discharge points (discharge points and nearby water)</li> <li>Proper selection of cooling water intake and installation of fences to prevent intake of aquatic habitats</li> <li>Proper control of temperature on cooling water discharge</li> <li>Impact monitoring on the surrounding ecosystem caused by cooling water discharge</li> </ul>

Item	Survey target	Analysis methods	Mitigation measures
Waste	<ul style="list-style-type: none"> <li>Appropriate treatment and discharge of waste generated during construction and operation</li> </ul>	<ul style="list-style-type: none"> <li>Survey on types of waste generated (hazardous waste, municipal waste and construction soil etc.) and their approximate volumes and treatment methods</li> <li>Survey on organizational structure to manage waste</li> </ul>	<ul style="list-style-type: none"> <li>Appropriate waste storage in designated area</li> <li>Outsourcing waste treatment to registered contractors</li> <li>Development of waste management plan (including waste reduction/reuse, management/treatment methods, organizational management structure and audit system for contractors)</li> </ul>
Noise and vibration	<ul style="list-style-type: none"> <li>Impact caused by noise and vibration during construction and operation</li> </ul>	<ul style="list-style-type: none"> <li>Present noise survey in the area in which the project is located (baseline survey with sampling)</li> <li>Survey on noise sources and time of the occurrence during construction</li> <li>Noise level forecast during operation and comparison with criteria (Nigerian standards and international standards such as WBs)</li> </ul>	<ul style="list-style-type: none"> <li>Installation of noise barrier and muffler at noise source and noise monitoring (if necessary) during construction</li> <li>Careful location selection of noise generating equipment (such as gas turbine and heat recovery steam generator) inside a building and within the site property</li> <li>Regular noise monitoring at the site boundary (and receptor location if necessary)</li> </ul>
<b>Natural environment</b>			
Protected area and ecosystem	<ul style="list-style-type: none"> <li>Impact on terrestrial and marine ecosystem</li> </ul>	<ul style="list-style-type: none"> <li>Study on location of protected areas and important ecosystem (coral reefs, mangroves, Ramsar sites etc.)</li> <li>Baseline survey on terrestrial and marine habitats at and near the project site (ecologically valuable species and vulnerable species)</li> <li>Impact on the surrounding ecosystem during construction and operation (increase in water temperature and flow change caused by cooling water discharge)</li> </ul>	<ul style="list-style-type: none"> <li>Relocation of vegetation if necessary</li> <li>Regular ecosystem monitoring (especially near water discharge points)</li> <li>Conservation of natural environment near the site (including greening activities and worker's education)</li> </ul>

Item	Survey target	Analysis methods	Mitigation measures
Hydrology	<ul style="list-style-type: none"> <li>Impact on water flow caused by cooling water discharge (when water cooling system)</li> </ul>	<ul style="list-style-type: none"> <li>Survey on water flow condition near the site</li> <li>Survey on water intake and discharge points and methods</li> <li>Prediction of flow change caused by cooling water discharge and impact analysis on aquatic habitat</li> </ul>	<ul style="list-style-type: none"> <li>Installation of silt fence to prevent turbid water dispersion</li> <li>Installation of wastewater treatment equipment such as oil-water separator, septic tanks and neutralization device</li> <li>Regular water quality modeling of discharge around discharge points (discharge points and nearby water)</li> <li>Proper selection of cooling water intake and installation of fences to prevent intake of aquatic habitats</li> <li>Proper control of temperature on cooling water discharge</li> <li>Impact monitoring on the surrounding ecosystem caused by cooling water discharge</li> </ul>
Topography and geology	<ul style="list-style-type: none"> <li>Topographical deformation by land reclamation</li> </ul>	<ul style="list-style-type: none"> <li>Baseline survey on topographical and geological feature at the site and nearby area</li> <li>Impact analysis caused by land deformation</li> </ul>	<ul style="list-style-type: none"> <li>Careful selection of the project site to avoid large-scale land reclamation (in alternative assessment)</li> </ul>
<b>Social environment</b>			
Resettlement and land acquisition	<ul style="list-style-type: none"> <li>Scale of resettlement and impact on affected people caused by the plant development</li> </ul>	<ul style="list-style-type: none"> <li>Socioeconomic survey in the region (including population census, asset survey and household income survey)</li> </ul>	<ul style="list-style-type: none"> <li>RAP reparation</li> <li>Consultation with affected people and proper compensation and support to them</li> <li>Monitoring of affected people after resettlement</li> </ul>
Regional social environment *	<ul style="list-style-type: none"> <li>Impact on the livelihood of residents</li> </ul>	<ul style="list-style-type: none"> <li>Impact on the livelihood of nearby residents (any impact on agriculture and fishery)</li> <li>Impact forecast on the living environment of residents caused by construction and operation</li> <li>Impact on the livelihood caused by cooling water intake and discharge (when water cooling system equipped)</li> </ul>	<ul style="list-style-type: none"> <li>Consultation with residents (especially those who are potentially affected)</li> <li>Development of a grievance mechanism and setup of complaint desk for residents</li> <li>Local employment at the project</li> </ul>
Water use	<ul style="list-style-type: none"> <li>Impact on water use of nearby residents (fishing activity, river water use etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Impact forecast on the livelihood caused by cooling water intake and discharge (when water cooling system equipped)</li> <li>Survey on the livelihood of nearby residents (to see impact on agriculture and fishery)</li> <li>Water quality and flow impact prediction caused by wastewater during construction and plant operation</li> </ul>	<ul style="list-style-type: none"> <li>Proper implementation of explanation, compensation and support activities to PAPs</li> <li>Grievance mechanism development (complaint desk setup and grievance solving process)</li> </ul>



Item	Survey target	Analysis methods	Mitigation measures
Cultural heritage	<ul style="list-style-type: none"> <li>Impact on cultural heritage of nearby community</li> </ul>	<ul style="list-style-type: none"> <li>Site reconnaissance and data analysis of the site and nearby area for cultural heritage and antiquities</li> <li>Interview with the community</li> </ul>	<ul style="list-style-type: none"> <li>Proper implementation of explanation, compensation and support activities to PAPs</li> <li>Grievance mechanism development (complaint desk setup and grievance solving process)</li> </ul>
Landscape	<ul style="list-style-type: none"> <li>Visual impact caused by project facilities</li> </ul>	<ul style="list-style-type: none"> <li>Nearby site landscape observation</li> <li>Landscape forecast with project structure installation</li> </ul>	<ul style="list-style-type: none"> <li>Harmonization with the surrounding environment considering structure location, color and design</li> </ul>
Gender/Children's right	<ul style="list-style-type: none"> <li>Necessity of special consideration on women children and socially vulnerable people</li> </ul>	<ul style="list-style-type: none"> <li>Population of female and children in PAPs</li> <li>Access to medical care</li> <li>School enrollment</li> <li>Child labor issues around the site</li> </ul>	<ul style="list-style-type: none"> <li>Special consideration for female in public consultation</li> <li>Improvement of access to medical care</li> <li>Improvement of school enrollment</li> </ul>
HIV/AIDS and diseases	<ul style="list-style-type: none"> <li>Prevention measures on infectious diseases during project implementation</li> </ul>	<ul style="list-style-type: none"> <li>Morbidity rate of infectious diseases and vaccination rate</li> <li>Access to medical care</li> </ul>	<ul style="list-style-type: none"> <li>Improvement of access to medical care</li> <li>Health and sanitary training</li> </ul>
Working environment	<ul style="list-style-type: none"> <li>Accident occurrence</li> </ul>	<ul style="list-style-type: none"> <li>Review on accident records and OHS system</li> </ul>	<ul style="list-style-type: none"> <li>OHS training</li> </ul>
<b>Other</b>			
Accidents	<ul style="list-style-type: none"> <li>Accident responses and measures to prevent accidents during construction and operation</li> </ul>	<ul style="list-style-type: none"> <li>Risk assessment of accident occurrence</li> <li>Survey on prevention measure planning and organizational structure</li> </ul>	<ul style="list-style-type: none"> <li>Development of a safety management plan</li> <li>Proper installation of accident prevention measure/response equipment such as fire extinguishers, oil spillage prevention, alarm system etc.</li> <li>Preparation of emergency response procedures</li> <li>Training on work safety</li> <li>Installation of spill containment around liquid storage tanks</li> </ul>
Climate change	<ul style="list-style-type: none"> <li>CO<sub>2</sub> emissions caused by the plant</li> </ul>	<ul style="list-style-type: none"> <li>CO<sub>2</sub> emission prediction from the plant</li> </ul>	<ul style="list-style-type: none"> <li>Promotion of an efficient power generation system such as combined cycle, implementing government policy</li> <li>CO<sub>2</sub> emission monitoring (annual)</li> </ul>

\* includes poverty, Regional economy, land use and regional resource, existing social infrastructure and services, Misdistribution of Benefit and Damage, Local Conflict of Interest.

Source: JICA Study Team

**Table 8-5.7 Important impact items and monitoring (framework) for gas-fired power generation**

Item		Period	Monitoring contents	Location	Frequency
<b>Environmental pollution</b>					
Air quality	Ambient air	Operation	• NO <sub>2</sub> , SO <sub>2</sub> , CO, PM10	• Select appropriate locations in EIA	• Once a month
	Exhaust gas	Operation	• NOx, PM	• Stacks at gas turbine and heat recovery boiler	• Ongoing
Water quality	Ambient water	Construction	• Turbid water (visual inspection)	• Water body nearby the site	• Regularly
		Operation	• Items in the national environmental standards	• Location without any influence from wastewater discharge and downstream of discharge point (select appropriate points in EIA)	• Ongoing or once a month
	Wastewater	Construction/Operation	• pH, residual chlorine, TSS, oil • Other items in the national wastewater quality criteria	• Waste discharge point	• Ongoing or once a month
	Thermal water	Operation	• pH, residual chlorine, water temperature	• Intake point and discharge point	• Ongoing
Waste		Construction/Operation	• Waste generation status (waste types and quantity) and treatment/disposal performance	• Construction site and power plant	• Regularly
Noise and vibration		Construction/Operation	• Noise level during construction and operation	• Site boundary • Locations of receptors who need special care	• Once a month
<b>Natural environment</b>					
Protected area and ecosystem		Construction/Operation	• Impact on terrestrial and marine ecosystem (visual inspection and interview with local people etc.)	• Select appropriate locations in EIA	• Once a month
Hydrology (when cooling water system equipped)		Operation	• Quantity of thermal water discharge • Hydrological change near intake and discharge points (visual inspection and interview with local people etc.)	• Nearby intake and discharge points	• Once a month
Topography and geology		Construction	• Impact on topographical change caused by land reclamation (cutting etc.) (visual inspection)	• Construction site	• When necessary
<b>Social environment</b>					
Resettlement and land acquisition	Before construction		• Number of households to be resettled and PAPs	• Residential area of PAPs	• Once before construction
	Construction/Operation		• Implementation status of compensation	• Residential area of PAPs	• Once a month

Item	Period	Monitoring contents	Location	Frequency
		<ul style="list-style-type: none"> <li>• Living condition of PAPs</li> </ul>		
Regional social environment	Construction/Operation	<ul style="list-style-type: none"> <li>• Impact on living condition of nearby residents (visual observation, interview with residents etc.)</li> <li>• Grievance</li> </ul>	• Residential area nearby	• Once a month
Other				
Accidents	Construction/Operation	<ul style="list-style-type: none"> <li>• Implementation status of safety management plan</li> <li>• Accident occurrence records</li> </ul>	• Construction site and power generation facility	• Regularly
Climate change	Operation	• CO <sub>2</sub> emission performance	• Power generation facility	• Once a month

Source: JICA Study Team

**Table 8-5.8 Important impact items and mitigation measures (framework) for transmission line**

Item	Survey target	Analysis methods	Mitigation measures
Alternative comparison	<ul style="list-style-type: none"> <li>Alternative assessment (especially “zero option” and location)</li> </ul>	<ul style="list-style-type: none"> <li>Alternative project comparison including zero option</li> <li>Project site alternative comparison                             <ul style="list-style-type: none"> <li>✓ Comparison of the number of affected people to be resettled (approximation) caused by the project construction</li> <li>✓ Comparison of distances from important ecosystems and protected areas</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>By comparing alternatives, adopt a proposal that has less impact on the environment and society, such as a plan with less resident relocation and less impact on important ecosystems/protected areas</li> </ul>
<b>Natural environment</b>			
Protected area and ecosystem	<ul style="list-style-type: none"> <li>Impact on terrestrial and marine ecosystem (dividing protected area (when construction in protected area), degradation of protected area environment, decrease in habitats for vulnerable species and bird strike)</li> </ul>	<ul style="list-style-type: none"> <li>Study on location of protected areas and important ecosystem (coral reefs, mangroves, Ramsar sites etc.)</li> <li>Baseline survey on terrestrial and marine habitats at and near the project site (ecologically valuable species and vulnerable species)</li> <li>Impact on the surrounding ecosystem during construction (turbid water discharge, noise from construction machinery etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Relocation of vegetation if necessary</li> <li>Regular ecosystem monitoring (especially near water discharge points)</li> <li>Conservation of natural environment near the site (including greening activities and worker’s education)</li> </ul>
<b>Social environment</b>			
Resettlement and land acquisition	<ul style="list-style-type: none"> <li>Scale of resettlement and impact on affected people caused by the plant development</li> </ul>	<ul style="list-style-type: none"> <li>Socioeconomic survey in the region (including population census, asset survey and household income survey)</li> </ul>	<ul style="list-style-type: none"> <li>RAP reparation</li> <li>Consultation with affected people and proper compensation and support to them</li> <li>Monitoring of affected people after resettlement</li> </ul>
Regional social environment *	<ul style="list-style-type: none"> <li>Impact on the livelihood of residents</li> </ul>	<ul style="list-style-type: none"> <li>Impact on the livelihood of nearby residents (any impact on agriculture and fishery)</li> <li>Impact forecast on the living environment of residents caused by construction</li> </ul>	<ul style="list-style-type: none"> <li>Consultation with residents (especially those who are potentially affected)</li> <li>Development of a grievance mechanism and setup of complaint desk for residents</li> <li>Local employment at the project</li> </ul>
Cultural heritage	<ul style="list-style-type: none"> <li>Impact on cultural heritage of nearby community</li> </ul>	<ul style="list-style-type: none"> <li>Site reconnaissance and data analysis of the site and nearby area for cultural heritage and antiquities</li> <li>Interview with the community</li> </ul>	<ul style="list-style-type: none"> <li>Proper implementation of explanation, compensation and support activities to PAPs</li> <li>Grievance mechanism development (complaint desk setup and grievance solving process)</li> </ul>
Landscape	<ul style="list-style-type: none"> <li>Visual impact caused by project facilities such as lattice towers</li> </ul>	<ul style="list-style-type: none"> <li>Nearby site landscape observation</li> <li>Landscape forecast with the project structure installation</li> </ul>	<ul style="list-style-type: none"> <li>Harmonization to surrounding environment considering structure location, color and design</li> </ul>

Item	Survey target	Analysis methods	Mitigation measures
Gender/Children's right	<ul style="list-style-type: none"> <li>Necessity of special consideration on women children and socially vulnerable people</li> </ul>	<ul style="list-style-type: none"> <li>Population of female and children in PAPs</li> <li>Access to medical care</li> <li>School enrollment</li> <li>Child labor issues around the site</li> </ul>	<ul style="list-style-type: none"> <li>Special consideration for females in public consultation</li> <li>Improvement of access to medical care</li> <li>Improvement of school enrollment</li> </ul>
HIV/AIDS and diseases	<ul style="list-style-type: none"> <li>Prevention measures on infectious diseases during project implementation</li> </ul>	<ul style="list-style-type: none"> <li>Morbidity rate of infectious diseases and vaccination rate</li> <li>Access to medical care</li> </ul>	<ul style="list-style-type: none"> <li>Improvement of access to medical care</li> <li>Health and sanitary training</li> </ul>
Working environment	<ul style="list-style-type: none"> <li>Accident occurrence</li> </ul>	<ul style="list-style-type: none"> <li>Review on accident records and OHS system</li> </ul>	<ul style="list-style-type: none"> <li>OHS training</li> </ul>
Other			
Accidents	<ul style="list-style-type: none"> <li>Accident responses and measures to prevent accidents during construction and operation</li> </ul>	<ul style="list-style-type: none"> <li>Risk assessment of accident occurrence</li> </ul>	<ul style="list-style-type: none"> <li>Development of safety management plan</li> <li>Proper installation of accident prevention measure/response equipment</li> <li>Preparation of emergency response procedures</li> <li>Training on work safety</li> </ul>
Impacts during construction	<ul style="list-style-type: none"> <li>Pollution during construction (noise and vibration, turbid water, particulates, exhaust gas, waste etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Survey on pollution sources (construction machinery etc.) and mitigation measures</li> <li>Waste types and volumes (hazardous waste, solid waste and waste soil etc.) and treatment methods</li> </ul>	<ul style="list-style-type: none"> <li>Noise prevention measures such as installation of soundproof/insulation walls and noise monitoring if necessary</li> <li>Proper waste storages at designated sites</li> <li>Proper management on construction vehicles</li> </ul>

Source: JICA Study Team

**Table 8-5.9 Important impact items and monitoring (framework) for transmission line**

Item	Period	Monitoring contents	Location	Frequency
<b>Natural environment</b>				
Protected area and ecosystem	Construction/Operation	<ul style="list-style-type: none"> <li>Impact on terrestrial and marine ecosystem (visual inspection and interview with local people etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Select appropriate locations in EIA</li> </ul>	<ul style="list-style-type: none"> <li>Once a month</li> </ul>
<b>Social environment</b>				
Resettlement and land acquisition	Before construction	<ul style="list-style-type: none"> <li>Number of households to be resettled and PAPs</li> </ul>	<ul style="list-style-type: none"> <li>Residential area of PAPs</li> </ul>	<ul style="list-style-type: none"> <li>Once before construction</li> </ul>
	Construction/Operation	<ul style="list-style-type: none"> <li>Implementation status of compensation</li> <li>Living condition of PAPs</li> </ul>	<ul style="list-style-type: none"> <li>Residential area of PAPs</li> </ul>	<ul style="list-style-type: none"> <li>Once a month</li> </ul>
Regional social environment	Construction/Operation	<ul style="list-style-type: none"> <li>Impact on living condition of nearby residents (visual observation, interview with residents etc.)</li> <li>Grievance</li> </ul>	<ul style="list-style-type: none"> <li>Residential area nearby</li> </ul>	<ul style="list-style-type: none"> <li>Once a month</li> </ul>
<b>Other</b>				
Accidents	Construction/Operation	<ul style="list-style-type: none"> <li>Implementation status of safety management plan</li> <li>Accident occurrence records</li> </ul>	<ul style="list-style-type: none"> <li>Construction site and transmission lines and towers</li> </ul>	<ul style="list-style-type: none"> <li>Regularly</li> </ul>
Impacts during construction	Construction	<ul style="list-style-type: none"> <li>Particulates, turbid water and noise generation monitoring</li> <li>Air quality and noise monitoring at boundaries of protected area, residential area and construction site</li> </ul>	<ul style="list-style-type: none"> <li>Construction site</li> </ul>	<ul style="list-style-type: none"> <li>Once a month</li> </ul>

Source: JICA Study Team

## 8-6 Stakeholder Meetings

Stakeholder meetings, as part of the following workshops, were held to hear opinions on the Environmental and social consideration in this Master Plan. Opinions from the stakeholders were discussed within TWG (ESC) and incorporated in the Master Plan as necessary.

Inception Workshop (the 1st JCC)	
Date/venue: September 4, 2015 at the FMPWH conference room	
Participants: FMPWH, TCN, NERC, REA, NPC, FMEEnv, FMWR, WB, UNIDO, AFD, USAIDS etc., 36 in total	
Meeting summary	Response in the Master Plan
The JICA Guidelines and the environmental and social consideration study for the project were briefly explained. FMEEnv pointed out that the Master Plan should consider GHG reduction from power sector in terms of international needs and reduction in wood fuel consumption.	Considering the importance of the GHG reduction efforts, CO <sub>2</sub> emission was set at one of the viewpoints for analyzing alternative scenarios. Wood fuel consumption can be reduced as expected, since electricity is widely distributed to citizens.

The 1st Technical Workshop (TWG)	
Date/venue: February 4, 2016 at TCN Hall	
Participants: FMPWH, TCN, WB, UNIDO, FMEEnv, NAPTIN, AFD, USAID, NERC, Nigeria Infrastructure Advisory Facility, ECN, MBMP, GIZ, BPE etc., 73 in total	
Meeting summary	Response in the Master Plan
Technical information, especially power demand forecast, power system development planning methods and scoping for SEA was discussed. For environmental and social considerations, the potential of renewable energy installation was raised and FMEEnv noted that INDC should be taken into account for Master pPan development. The JICA Team explained that scoping was done qualitatively considering the baseline status of Nigeria and general power system information, whereupon environmental and social concerns and potential impacts were shared with participants. It was also explained that power development scenario is to be assessed with impacts on, for example, climate change and air quality in each scenario, to plan a well-balanced development considering environment and cost aspects.	For the power development, the impacts on each alternative scenario were analyzed, including climate change and the preferable scenario selected, balancing environmental and development cost aspects. Conformity with INDC and NPCC was also reviewed.

The 2nd Technical Workshop (TWG)	
Date/venue: February 13, 2017 at TCN Hall	
Participants: Power sector personnel who will lead the future Master Plan revision (FMPWH, TCN, NERC, REA, NDPHC etc.), 52 in total	
Meeting summary	Response in the Master Plan
The Working Group was held with stakeholders who will lead the Master Plan revision in future. TWG(ESC) explained about environmental social considerations on the Master Plan development, as well as procedures and activities for the revision. A participant asked what SEA would do if it ended up developing environmentally fragile areas while planning power generation. The Team emphasized the importance of avoiding such areas at the planning stage and the fact that special care should be taken in terms of the environmental and social aspects.	N/A

Draft Report Seminar	
Date/venue: December 13, 2018 at the FMPWH conference room	
Participants : FMPWH, TCN, NERC, ECN, AEDC, GIZ etc., 36 in total	
Meeting summary	Response in the Master Plan
<p>The result of the environmental social considerations and scenario analysis was presented in the seminar. A participant questioned the reason behind assigning D as environmental impact for all environmental pollution items, except land subsidence in transmission line SEA. The project team explained that the environmental impacts in the field of pollution were limited during the construction period and insignificant compared to other types of power development projects. It was also mentioned that scoping in this SEA was only for the Master Plan stage and that obviously, an EIA would have to be developed for each individual project.</p>	<p>It was added in 8-3 "SEA Approach of the Master Plan development" of the report that EIA, including scoping, should be exclusively implemented for each individual project in reference to this SEA result, never directly applying the same scoping and assessment result of the SEA.</p>



**CHAPTER 9      Economic and Financial  
Analysis**

## **Chapter 9 Economic and Financial Analysis**

### **9-1 Economic Analysis**

#### **9-1-1 Objective and Methods**

##### **(1) Objective**

In this economic analysis, the economic viability of the Master Plan is assessed from the perspectives of the national economy of Nigeria. A cost-benefit analysis is also conducted to examine the magnitude of the economic benefits brought by implementing the Master Plan in comparison with the costs, i.e. the value of resources used for the Master Plan implementation as shown in economic costs.

##### **(2) Methods**

The methods applied for the economic analysis are described below. As the Master Plan covers only generation and transmission sub-sectors, the economic viability of the distribution sub-sector is not assessed in this economic analysis.

- 1) Indicators estimated in this analysis to show economic viability include the economic internal rate of return (EIRR), benefit-cost ratio (B/C) and net present value (NPV).
- 2) The period for the economic analysis is set as 32 years, namely 2018 to 2049.
- 3) A cut-off rate of 10%, with which the EIRR of the Master Plan is compared to appraise the economic viability of the investment, is applied in this analysis. There might be no standard social discount rate or opportunity cost of capital as designated by the Federal Ministry of Budget and National Planning according to an interview survey conducted by a Technical Working Group (TWG) member and donor agencies apply their own social discount rates as deemed suitable for their projects. The economic analysis for the “Electricity Transmission Project for the Federal Republic of Nigeria” assisted by the World Bank (WB), for example, applies a cut-off rate of 7%, despite the project EIRR being estimated as high as 46.7%, while the WB applies a social discount rate of 5% when appraising the “Nigeria Electrification Project”, with an EIRR estimated at 25%. Besides, the African Development Bank (AfDB) applies social discount rates of 10-12% depending on the project types and years of appraisal involved. The cut-off rate of 10% is applied as a middle figure.
- 4) The economic benefit of the Master Plan counted in this analysis is derived from the increased power supply. Unless the Master Plan is implemented, electricity will have to be supplied solely with existing facilities and equipment and their scope to supply power will presumably decline to zero twenty years from now. With the Master Plan implementation, sufficient electric power may be available to meet demand. The difference between the power to be supplied solely via existing facilities/equipment and that demanded is assumed to be the increment of power supply by the Master Plan implementation and the benefit in the Master Plan is calculated by multiplying the

difference in electricity supply with the “Willingness to Pay” for electricity, details of which are described below.

- 5) As the Master Plan excludes the distribution sub-sector, the economic benefit of the Master Plan implementation is computed based on the generation and transmission tariffs as a proportion of the end-user tariff. According to the end-user tariff by DisCo defined in the Multi-year Tariff Order (MYTO) and the volumes of electricity supplied to respective DisCo, the weighted-average customer tariff is calculated as USD 0.188/kWh. As the generation tariff in MYTO was defined by the source energy type, the weighted-average generation tariff is calculated as USD 0.0961/kWh with the wholesale price defined in the MYTO by the source energy type and volume of generated energy planned for the period 2018-2040 by source energy type, while the transmission tariff is defined as USD 0.0170/kWh in the MYTO. The generation and transmission tariffs as a proportion of the user tariff are assumed to constitute 51 and 9% respectively ( $=0.0961/0.188$  and  $0.017/0.188$ ). Of the overall economic benefit of power supply, 60% is regarded as the Master Plan benefit.
- 6) The “Willingness to Pay” for electricity in Nigeria is said to equate to USD 0.20/kWh. Based on a survey of 835 households conducted in 2012, the WB estimated the “Willingness to Pay” for households in Nigeria at USD 0.16/kWh at 2012 prices, which was converted to USD 0.18/kWh at 2016 prices by a WB appraisal mission in 2018. Meanwhile, the WB also introduced information indicating that the cost of self-generation had reached USD 0.20-0.30/kWh<sup>1</sup>. The “Nigeria Power Baseline Report” issued by the Advisory Power Team in the Office of Vice President in August 2015 shows estimates of the private generation cost at NGN 62-94/kWh, which can be converted to USD 0.30-0.45/kWh at the exchange rate at the time. Considering that more than 40% of electricity was used by the commercial and industrial sectors in 2015 and that the current self-generation cost is estimated to far exceed USD 0.20/kWh, the “Willingness to Pay” for electricity in this economic analysis is conservatively set as USD 0.20/kWh.
- 7) The investment costs estimated in Chapter 7 in this report exclude the costs of developing transmission facilities/equipment after stepping down to 132 kV (subordinate system). In this analysis, the investment cost of the transmission sub-sector, including the subordinate system, is estimated at 25% of that of the generation sub-sector referring to final reports of similar studies conducted by JICA such as “Program Formation Survey of Power Sector Development in the Republic of the Union of Myanmar”, “Project for Least Cost Generation and Transmission Expansion Plan in Pakistan” and “The Project for Formulation of the Power System Master Plan in Dar Es Salaam and Coast Regions and Review of Power System Master Plan 2012”, etc. Consequently, the investment cost of the subordinate system is estimated at USD 0.45/W.
- 8) The national average technical loss in the power distribution sub-sector for 2018-2020 is assumed to be 12.5%, referring to the “Nigeria Power Baseline Report”, while the loss rate will presumably decrease by 0.25% per year during 2021-2030 and remain 10% after 2030. Losses other than the

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<sup>1</sup> Project Appraisal Document for the “Electricity Transmission Project” (January, 2018)

technical loss in the distribution sub-sector are not considered as the economic benefit occurs once the electricity is distributed to consumers, even if the tariffs are not collected by electricity distribution companies. However, since issues on the current high commercial and tariff collection loss are triggering fatal problems affecting power sector sustainability, failure to consider the technical, commercial and tariff collection loss in the distribution sub-sector when estimating the economic benefit does not mean these distribution sub-sector losses can be neglected or remain unsolved.

- 9) When the Master Plan is implemented, some electricity can be exported and the income from this also counts as an economic and financial benefit of the Master Plan implementation. The importing countries are thought to be Niger, Benin and Burkina Faso. The selling price is set at USD 0.15/kWh referring to the Consultancy Service Report of the “WAPP North Core 330 kV Project” (December 2008).
- 10) The operation and maintenance (O&M) costs of the power stations, including fuel costs, are estimated by the energy source type, assuming half the O&M costs, excluding fuel, are in foreign currency and the remainder in local currency. As for fuel costs, the costs for natural gas and nuclear fuel are presumed to be in foreign currency while that for coal is regarded as local currency.
- 11) The O&M costs of transmission and substation facilities/equipment are estimated as 1 and 1.5% of investments costs, respectively, while the foreign and local currency portions of the O&M costs for transmission and substation facilities/equipment are assumed to be 50%. By comparing the O&M costs for transmission and substation facilities/equipment estimated by the JICA Study Team and the operational expenditures required to provide transmission services (TSP) budgeted or forecasted by TCN, the additional O&M cost of USD 4,825/GWh is estimated as another operation cost and presumed as part of the local currency cost, as shown in Table 9-1.1

**Table 9-1.1 Comparison of O&M Costs between JICA Study and TCN's Forecast**

Year	M/P						TCN			
	O&M Cost of Facilities /Equipment (USD million)	Incremental Transmission by M/P (GWh)	Unit O&M Cost (USD/GWh)	Other Operation Cost (USD million)	Total Operation Cost (USD million)	Economic Operation Cost (USD million)	Opex. for TSP (NGN million)	Opex. for TSP (USD million)	Bulk Supply (GWh)	Unot Opex. (USD/GWh)
2018	7	3,845	1,818	19	26	23	60,051	197	32,537	6,051
2019	19	14,182	1,305	68	87	79	67,946	223	35,344	6,303
2020	32	22,677	1,410	109	141	128	75,841	249	38,392	6,477
2021	41	31,801	1,286	153	194	176	81,762	268	41,704	6,428
2022	63	45,849	1,381	221	285	257	85,721	281	45,547	6,171
2023	83	56,977	1,458	275	358	324	89,705	294	49,744	5,913
2024	108	69,090	1,556	333	441	399	93,713	307	54,325	5,656
2025	123	82,267	1,496	397	520	471	99,526	326	59,326	5,500
2026	136	96,563	1,410	466	602	545			<b>Average</b>	<b>6,062</b>
2027	140	106,176	1,320	512	652	590				
2028	151	116,183	1,302	561	712	644				
2029	163	126,593	1,285	611	774	700				
2030	171	136,592	1,249	659	830	751				
2031	175	144,429	1,210	697	872	789				
2032	181	152,254	1,187	735	915	828				
2033	187	160,047	1,168	772	959	868				
2034	193	167,883	1,151	810	1,003	908				
2035	199	175,516	1,133	847	1,046	946				
2036	204	183,065	1,117	883	1,088	984				
2037	211	190,505	1,105	919	1,130	1,022				
2038	218	198,074	1,101	956	1,174	1,062				
2039	226	204,116	1,105	985	1,211	1,095				
2040	232	210,276	1,103	1,015	1,247	1,128				
2041	232	210,276	1,103	1,015	1,247	1,128				
2042	232	210,276	1,103	1,015	1,247	1,128				
2043	232	210,276	1,103	1,015	1,247	1,128				
2044	232	210,276	1,103	1,015	1,247	1,128				
2045	232	210,276	1,103	1,015	1,247	1,128				
2046	232	210,276	1,103	1,015	1,247	1,128				
2047	232	210,276	1,103	1,015	1,247	1,128				
2048	232	210,276	1,103	1,015	1,247	1,128				
2049	232	210,276	1,103	1,015	1,247	1,128				
		<b>Average</b>	<b>1,237</b>							
									<b>Difference</b>	<b>4,825</b>

Source: JICA Study Team

- 12) Taxes and duties are deducted to convert financial costs to economic costs. Moreover, the Standard Conversion Factor (SCF) applicable for converting financial prices of local currency portion to economic prices is set as 0.95, also referring to the Consultancy Service Report of the “WAPP North Core 330 kV Project” (December 2008).
- 13) Service lives of facilities/equipment for hydro-, thermal-, nuclear- and renewable energy power generation and transmission are respectively assumed as 50, 30, 40, 20 and 35 years. The residual values of the facilities/equipment at the end of the analytical period are counted as negative costs in the final year. The service life for equipment/fixtures used for renovation, to be conducted in 20 years after thermal generation stations have been in service, is set at ten years and the residual values at the end of the period also count as a negative cost in the final year.

## 9-1-2 Results of Economic Analysis

### (1) Estimated Indicators to Show Economic Viability

The estimated EIRR, benefit-cost ratio (B/C) and net present value (NPV, at a discount rate of 10%) are shown in Table 9-1.2. The Master Plan is economically viable and to be implemented to develop the national economy efficiently, as the EIRR exceeds the cut-off rate of 10%, the B/C surpasses 1.0 and the NPV is positive.

**Table 9-1.2 Estimated Indicators on the Economic Viability of the Master Plan**

Economic Internal Rate of Return (EIRR)	15.1%
Benefit-cost Ratio (B/C)	1.22
Net present Value (NPV, at discount rate of 10%, USD million)	18,448

Source: JICA Study Team

### (2) Results of the Sensitivity Analysis

The EIRRs, B/Cs and NPVs, given a 22% increase in investment and O&M costs and an 18% decrease in benefits, are shown in Table 9-1.3. In these cases, the EIRRs are close to the cut-off rate of 10% and the B/Cs are almost 1.00. If the cost increases or the benefit decreases further, the Master Plan would no longer be economically viable.

**Table 9-1.3 Results of the Sensitivity Analysis**

Case	EIRR	B/C	NPV
22% increase in costs	10.1%	1.00	USD 240 million
18% decrease in benefits	10.1%	1.00	USD 230 million

Source: JICA Study Team

The benefits and costs streams of the Master Plan during the period of economic analysis are given in Table 9-1.4 for reference.

**Table 9-1.4 Result of the Economic Analysis and Benefit-cost Stream in Base Case**

Indicators on Economic Viability

EIRR	15.1%
B/C	1.22
NPV (10% Discount, USD million)	18,448

Cost-Benefit Stream (USD million at constant prices of 2018)

Year	Benefits		Costs		Balance
	Domestic Power Supply	Export	Investment Cost	O&M Cost	
2018	161	372	1,239	2,315	-3,021
2019	1,384	395	2,331	2,689	-3,241
2020	2,387	416	4,036	2,877	-4,110
2021	3,461	443	4,799	3,217	-4,112
2022	5,125	471	5,563	3,785	-3,753
2023	6,438	499	5,676	4,134	-2,872
2024	7,869	529	6,518	4,649	-2,770
2025	9,426	559	5,299	5,117	-431
2026	11,114	595	4,985	5,702	1,021
2027	12,239	630	4,356	5,882	2,631
2028	13,413	665	4,588	6,128	3,362
2029	14,634	700	5,290	6,016	4,029
2030	15,808	733	6,372	6,371	3,799
2031	16,729	758	4,803	6,425	6,259
2032	17,649	782	5,146	6,639	6,646
2033	18,566	805	5,401	6,980	6,991
2034	19,482	836	4,046	6,856	9,416
2035	20,382	856	3,916	7,083	10,239
2036	21,273	876	3,382	7,370	11,396
2037	22,150	896	1,141	7,656	14,249
2038	23,043	915	853	7,936	15,169
2039	23,752	935	1,032	8,220	15,436
2040	24,476	955	1,307	8,509	15,616
2041	24,476	955	961	8,509	15,961
2042	24,476	955	575	8,509	16,348
2043	24,476	955	294	8,509	16,628
2044	24,476	955	482	8,509	16,440
2045	24,476	955	432	8,509	16,491
2046	24,476	955	440	8,509	16,482
2047	24,476	955	560	8,509	16,362
2048	24,476	955	603	8,509	16,319
2049	24,476	955	-34,755	8,509	51,677
Total	531,245	24,216	270,803	209,131	284,658

Discounted Benefits and Cost (Discount Rete: 10%)				
Domestic Power Supply	Export	Investment Cost	O&M Cost	Balance
147	338	1,126	2,104	-2,746
1,144	326	1,927	2,222	-2,679
1,793	313	3,032	2,162	-3,088
2,364	302	3,278	2,197	-2,808
3,182	292	3,454	2,350	-2,330
3,634	282	3,204	2,333	-1,621
4,038	271	3,345	2,386	-1,421
4,397	261	2,472	2,387	-201
4,713	252	2,114	2,418	433
4,719	243	1,680	2,268	1,015
4,701	233	1,608	2,148	1,178
4,663	223	1,686	1,917	1,284
4,579	212	1,846	1,845	1,100
4,405	200	1,265	1,692	1,648
4,225	187	1,232	1,589	1,591
4,041	175	1,175	1,519	1,521
3,854	165	801	1,356	1,863
3,666	154	704	1,274	1,842
3,478	143	553	1,205	1,863
3,292	133	170	1,138	2,118
3,114	124	115	1,072	2,050
2,918	115	127	1,010	1,896
2,733	107	146	950	1,744
2,485	97	98	864	1,620
2,259	88	53	785	1,509
2,054	80	25	714	1,395
1,867	73	37	649	1,254
1,697	66	30	590	1,144
1,543	60	28	536	1,039
1,403	55	32	488	938
1,275	50	31	443	850
1,159	45	-1,646	403	2,448
95,543	5,666	35,745	47,016	18,448

Source: JICA Study Team

## **9-2 Financial Analysis**

### **9-2-1 Objective and Methods**

#### **(1) Objective**

In this financial analysis, the financial soundness of the Master Plan is assessed by comparing the investment and O&M costs and revenues for power-generating and -transmitting entities. Suggestions on policies to finance the investment costs of the projects included in the Master Plan are explored according to the project characteristics and the financial internal rate of return (FIRR).

#### **(2) Methods**

Methods applied for the financial analysis are described below. As the Master Plan covers only the generation and transmission sub-sectors, the financial viability in the distribution sub-sector is not assessed in this financial analysis as well.

- 1) Indicators estimated in this analysis to show financial feasibility include the FIRR, benefit-cost ratio (B/C) and net present value (NPV).
- 2) The period for the financial analysis is set as 32 years, namely from 2018 to 2049.
- 3) A cut-off rate of 9%, with which the FIRR of the Master Plan is compared to appraise the financial feasibility of the investment, is adopted in this analysis. According to the WB database, the average real interest rate, i.e. the one that applies when the private sector borrows money from commercial banks and is adjusted by the GDP deflator, was 8.6% for the period 2011-2017 in Nigeria.
- 4) The financial benefits of revenues boosted by implementing Master Plan are calculated by multiplying incremental generated and transmitted power, which, in turn, are estimated based on the increase in power supply with the weighted-average wholesale generation prices and the transmission charge provided in the MYTO. The volume of electricity generated and transmitted with existing facilities/equipment is assumed to decrease to zero in twenty years, as presumed in the economic analysis. The increase in generated and transmitted electricity volumes due to implementing the Master Plan are calculated as the difference in volumes between electricity generated/transmitted by existing facilities/equipment and electricity generated and transmitted to meet demand. The weighted-average generation tariff is calculated with the wholesale price defined in the MYTO by the type of energy source for generation and the volume of generated energy estimated for the period 2018-2040 by the energy source for generation. To estimate the financial benefit of the generation sub-sector, electricity losses in the transmission sub-sector are included when estimating revenue (not taking losses in the transmission sub-sector into account).
- 5) Transmission Use of System (TUOS) Charge includes those for the Transmission Service Provider (TSP), the System Operator (SO) and the Market Operator (MO), etc. The cost of the transmission sub-sector estimated in this Master Plan only includes capital and O&M costs of the transmission facilities/equipment and other operation costs for TSP. Therefore, the benefit in this financial



analysis is calculated by multiplying the volume of increased transmitted electricity by the Master Plan implementation with the TSP tariff. To estimate the financial benefit of the transmission sub-sector, electricity losses in the distribution sub-sector are included (not taking losses in the distribution sub-sector into account).

- 6) Financial analyses are conducted for overall Master Plan and the generation and transmission sub-sectors respectively and a sensitivity analysis is also performed to estimate the extent to which the cost can be increased or revenues reduced while retaining financial viability.
- 7) The generation prices of 2016, as defined in the MYTO effected in May 2012 and the transmission charge of 2018, as provided in the MYTO 2015 and effective since February 2016, are applied to estimate the revenue increase. The prices and charge are converted to USD at the exchange rates between Naira and USD applicable when setting the tariff.
- 8) As was done in the economic analysis, the investment and O&M costs of the subordinate transmission system after stepping down to 132 kV are included in the Master Plan cost.
- 9) O&M and other operation costs are estimated as in the economic analysis except when converting financial costs to economic costs.
- 10) As done in the economic analysis, service lives are set according to the types of facilities/equipment and their residual values at the end of the analytical period are counted as negative costs in the final year of the analytical period.

## 9-2-2 Results of the Financial Analysis

### (1) Estimated Indicators to Show the Financial Feasibility

As shown in Table 9-2.1, the Master Plan is financially feasible and implementable and since the FIRRs in the overall Master Plan and the generation and transmission sub-sectors exceed the cut-off rate of 9%, the B/Cs surpass 1.0 and the NPVs are positive. Provided the tariff is collected properly, the investment and O&M costs could be recouped through accrued revenue.

**Table 9-2.1 Estimated Indicators on the Financial Feasibility of the Master Plan**

<b>Overall Master Plan</b>	
Financial Internal Rate of Return (FIRR)	11.7%
Benefit-cost Ratio (B/C)	1.14
Net present Value (NPV, at discount rate of 9%, USD million)	13,320
<b>Generation Sub-sector</b>	
Financial Internal Rate of Return (FIRR)	11.6%
Benefit-cost Ratio (B/C)	1.13
Net present Value (NPV, at discount rate of 9%, USD million)	10,747
<b>Transmission Sub-sector</b>	
Financial Internal Rate of Return (FIRR)	12.2%
Benefit-cost Ratio (B/C)	1.17
Net present Value (NPV, at discount rate of 9%, USD million)	2,257

Source: JICA Study Team

## (2) Results of the Sensitivity Analysis

The results of the sensitivity analysis are shown in Table 9-2.2. For the overall Master Plan, it is estimated that the Master Plan remains financially feasible, even in the event that costs increase by up to 13% or revenue declines by 11%. The Master Plan, however, may lose its financial viability in case of further cost increase or revenue decrease.

For the generation sub-sector, the sub-sector remains financially feasible, even if costs increase by up to 12.5% or revenue declines by 11%. For the transmission sub-sector, financial soundness can be maintained with an increase of up to 17% in investment and O&M costs and a decrease of up to 14% in revenue collection.

The results of this sensitivity analysis reveal reducing aggregated technical, commercial and collection (ATC&C) losses in the distribution sub-sector, which currently remains at 55% as a crucial challenge; not only for the distribution sub-sector but also the generation and transmission sub-sectors, i.e. for the overall power sector, since end-user tariff collection is the source from which the revenue collection of generation and transmission sub-sectors come.

**Table 9-2.2 Results of the Sensitivity Analysis**

	Case	FIRR	B/C	NPV
Overall Master Plan	13% increase in costs	9.1%	1.00	USD 541 million
	11% decrease in benefit	9.2%	1.01	USD 1,002 million
Generation Sub-sector	12.5% increase in costs	9.1%	1.00	USD 276 million
	11% decrease in benefit	9.1%	1.00	USD 351 million
Transmission Sub-sector	17% increase in costs	9.0%	1.00	USD 40 million
	14% decrease in benefit	9.2%	1.01	USD 127 million

Source: JICA Study Team

The revenue and cost streams of the Master Plan during the period of financial analysis are given in Table 9-2.3 for reference.

**Table 9-2.3 Result of the Financial Analysis and Revenue and Cost Stream in the Base Case**

Indicators on Financial Viability

FIRR	11.7%
B/C	1.14
NPV (9% Discount, USD million)	13,320

Revenue and Costs (USD million)

Year	Revenue			Cost						Balance	Discounted Revenues and Costs			
	Generation	Transmission	Total	Generation			Transmission				Total	Discount Rate		9%
				Investment	O&M	Total	Investment	O&M	Total			Revenue	Cost	
2018	309	70	379	730	2,419	3,149	595	26	620	3,770	-3,391	348	3,458	-3,111
2019	1,167	258	1,425	1,518	2,754	4,272	975	87	1,062	5,334	-3,909	1,199	4,489	-3,290
2020	1,857	413	2,270	3,181	2,902	6,083	1,133	141	1,274	7,358	-5,088	1,753	5,681	-3,929
2021	2,623	579	3,202	4,373	3,209	7,582	760	194	954	8,536	-5,334	2,268	6,047	-3,779
2022	3,905	835	4,740	4,044	3,780	7,824	1,905	285	2,190	10,014	-5,274	3,080	6,508	-3,428
2023	4,845	1,038	5,882	4,388	4,079	8,467	1,681	358	2,039	10,506	-4,623	3,508	6,264	-2,757
2024	6,040	1,259	7,299	4,894	4,600	9,494	2,078	441	2,519	12,013	-4,714	3,993	6,571	-2,579
2025	7,744	1,499	9,243	4,345	5,020	9,365	1,326	520	1,846	11,212	-1,969	4,639	5,627	-988
2026	8,908	1,759	10,667	4,218	5,559	9,777	1,115	602	1,718	11,495	-828	4,911	5,293	-381
2027	9,801	1,934	11,735	4,304	5,760	10,064	355	652	1,007	11,071	664	4,957	4,677	280
2028	11,004	2,116	13,120	3,926	5,964	9,890	980	712	1,692	11,582	1,539	5,085	4,488	596
2029	12,256	2,306	14,562	4,647	5,791	10,438	1,009	774	1,783	12,221	2,342	5,177	4,345	833
2030	13,131	2,488	15,619	6,130	6,113	12,243	682	830	1,512	13,754	1,865	5,095	4,486	608
2031	14,319	2,631	16,950	4,785	6,190	10,975	349	872	1,221	12,196	4,754	5,072	3,650	1,423
2032	15,346	2,773	18,119	4,994	6,376	11,370	507	915	1,422	12,792	5,328	4,974	3,512	1,463
2033	16,029	2,915	18,945	5,236	6,694	11,930	535	959	1,495	13,425	5,520	4,772	3,381	1,390
2034	17,963	3,058	21,021	3,793	6,813	10,606	532	1,003	1,535	12,140	8,881	4,857	2,805	2,052
2035	19,013	3,197	22,210	3,706	7,013	10,719	479	1,046	1,525	12,244	9,966	4,708	2,596	2,113
2036	19,702	3,335	23,037	3,135	7,276	10,411	479	1,088	1,567	11,979	11,058	4,480	2,330	2,151
2037	20,380	3,470	23,850	704	7,538	8,242	515	1,130	1,645	9,887	13,963	4,256	1,764	2,491
2038	21,066	3,608	24,674	275	7,790	8,065	637	1,174	1,811	9,876	14,798	4,039	1,617	2,422
2039	21,587	3,718	25,305	456	8,055	8,511	647	1,211	1,857	10,368	14,937	3,800	1,557	2,243
2040	22,118	3,830	25,948	857	8,325	9,182	539	1,247	1,786	10,968	14,980	3,575	1,511	2,064
2041	22,118	3,830	25,948	1,027	8,325	9,352	0	1,247	1,247	10,598	15,350	3,280	1,340	1,940
2042	22,118	3,830	25,948	614	8,325	8,939	0	1,247	1,247	10,185	15,763	3,009	1,181	1,828
2043	22,118	3,830	25,948	315	8,325	8,639	0	1,247	1,247	9,886	16,062	2,761	1,052	1,709
2044	22,118	3,830	25,948	515	8,325	8,840	0	1,247	1,247	10,087	15,862	2,533	985	1,548
2045	22,118	3,830	25,948	462	8,325	8,786	0	1,247	1,247	10,033	15,915	2,324	898	1,425
2046	22,118	3,830	25,948	470	8,325	8,795	0	1,247	1,247	10,042	15,907	2,132	825	1,307
2047	22,118	3,830	25,948	599	8,325	8,923	0	1,247	1,247	10,170	15,778	1,956	767	1,189
2048	22,118	3,830	25,948	645	8,325	8,969	0	1,247	1,247	10,216	15,732	1,794	706	1,088
2049	22,118	3,830	25,948	-30,399	8,325	-22,075	-6,767	1,247	-5,521	-27,595	53,543	1,646	-1,751	3,397
Total	470,171	83,565	553,736	52,886	204,943	257,829	13,046	27,484	40,531	298,360	255,376	111,981	98,662	13,320

Source: JICA Study Team

**CHAPTER 10    Recommendations for  
Realizing the Master Plan**

## **Chapter 10 Recommendations for Realizing the Master Plan**

### **10-1 Measures to be Taken to Realize the Master Plan**

#### **10-1-1 Financing for Investment**

Implementing the Master Plan requires investment costs of USD 79.3 billion in the power generation sector (USD 84.6 billion including facility and equipment for renovation) and USD 19.8 billion in the power transmission sector (of which USD 5.6 billion is for the major system before stepping down to 132 kV). Projects comprising the Master Plan can be roughly divided into those to be implemented by the public sector, such as constructing, operating and maintaining hydroelectric power plants and developing, operating and maintaining transmission network and projects to be implemented by the private sector, such as constructing and operating non-hydroelectric power plants. According to the results of a financial analysis, both the power generation and transmission sub-sectors are financially viable, with a financial internal rate of return (FIRR) exceeding 9% and adequate payments to the power generation and transmission sub-sectors will allow for the recovery of not only operating and maintenance costs, but also capital investment and financing. The investment fundraising measures by the public and private sectors are described below.

##### **(1) Financing for Public Sector Investment**

The construction and rehabilitation of hydroelectric power plants requires investment of approximately USD 10 billion, nearly USD 6 billion of which will be prepared with assistance from China. The remainder should be funded by government loans, primarily donor loans. Regardless of whether or not donor support, there is a need to properly implement environmental and residents' resettlement countermeasures when developing new sites and take sufficient care to avoid any dangers that could spark tribal conflicts.

The costs of investing in the transmission sub-sector, which also falls in the public sector, are estimated to be approximately USD 20 billion. Only about USD 1.3 billion has been committed for loans from international financial institutes (the World Bank, African Development Bank, Agence Française de Développement and Islamic Development Bank). The remaining investment funds are preferably borrowed by the Government, mainly from donors and re-lent to the Transmission Company of Nigeria (TCN). However, there is also a need to consider borrowing from public and private financial institutes directly by TCN, mainly for investments in subordinate systems. If a TCN or hydropower company is forced to borrow from a private financial institute, it is preferable to include government guarantees of repayment to minimize the interest rates.

As financial assistance from donor agencies covers only 6% of the investment requirements and the Government has limited capacity to fund the investment, there may not be scope to cover all the investment for the transmission sub-sector by public loans, and private financial initiatives may have to be introduced. Private financing can be realized by concession agreements, such as Build-Operate-Transfer (BOT) or Rehabilitate-Operate-Transfer (ROT), as a typical mode. It should be

necessary to define, before introducing concession contracts in the transmission sub-sector, how the private concessionaire, which will just develop or rehabilitate a part of the system, can be involved in operating the transmission network as the transmission system should be operated by the system operator as a united system, and the extent to which the concessionaires can collect the transmission charge to recover their capital, financing, operation and maintenance costs, as the relationship between developing or rehabilitating facilities and equipment of an area and the effects of incremental transmitted electricity is complex and determining the collectable charge would be difficult.

TCN, in collaboration with the Federal Ministry of Power, Works and Housing (FMPWH) and the Nigerian Electricity Regulatory Commission (NERC), should examine the framework of the concession method, develop model concession contracts in consultation with interested parties from the private sector, prepare guidelines for the private sector, which include explanations on incentives to promote the concessions and uploads the guidelines to the websites of FMPWH, NERC and TCN. Further, TCN should identify the projects suitable for concessions and invite proposals from the private sector.

With the exception of rural electrification and emergency projects, it is expected to be difficult to obtain grant aids from donors in future. Based on the results of the financial analysis, whether the borrower is the Government or TCN, it is desirable to allocate revenue to repay the borrowed money, which means implementing measures to reduce losses by the distribution companies (DisCos) and normalizing the payment of charges to the generation companies (GenCos) and TCN, as described in 10-1-2, is inevitable.

## **(2) Private-Sector Financing for Capital Investment**

Excluding hydroelectric power, the private sector invests in and manages the power generation sub-sector. When private companies and individuals consider entering the power generation sub-sector, including IPP projects, they are likely to hesitate to enter the sub-sector because of the high technical and commercial losses and the low rate of charge collection by DisCos at present. Sound development of the power generation sector is unlikely without some form of payment assurance of generation charges, except where electricity cannot be supplied for the GenCo's own reasons. To finance the investment smoothly by GenCos, measures to facilitate the application of loans from development financial institutes, such as the Nigerian Bank of Industry, the Nigerian Infrastructure Bank, the Nigerian Export and Import Bank and the Development Bank of Nigeria (DBN) will also be required. Specifically, the Bank of Industry, Nigeria is managing, under the Central Bank of Nigeria (CBN), the Power and Airline Intervention Fund (PAIF). Some describe the 15-year loan period of PAIF as too short. The total PAIF fund amounts to NGN 300 billion or USD 830 million and covers only 1% of the total investment cost of the generation sub-sector.

FMPWH should preferably conduct interviews with private companies that might be interested in investing in the power sector and with the results of the interview survey discuss with the Federal Ministry of Finance, CBN and the above-mentioned development financial institutes and prepare financial assistance schemes, such as lending, for private investors.

As the private sector would invest only when they are confident of recovering capital investment, operation, maintenance and financing costs as well as making commensurate with said risks, the relevant ministries and agencies have to implement measures to reduce losses in the distribution sub-sectors, as mentioned in Section 10-1-2, to encourage the private sector to invest in the power sector or generation sub-sector, among others.

### **10-1-2 Reduction of Loss and Improvement of the User Charge Collection by DisCos**

For both GenCos and TCNs, it is not possible for them to receive revenues from generation and transmission charges unless DisCos collect the same from their customers. The results of the sensitivity-analysis clearly show that even if the master plan for the power sector (power generation and transmission sub-sectors) is economically and financially viable and sound, the management of GenCos and TCNs does not stand under the current low rate of charge collection by DisCos.

Power Sector Recovery Programme 2017-2021 (PSRP) has formulated fundamental, concrete and orthodox action plans to reduce DisCos' losses and improve the charge collection rate as follows. These are essential for improving the DisCos' management and the soundness of the power sector and are considered effective if properly implemented. These are important action plans that can be regarded as prerequisites for the smooth implementation of the Master Plan:

- 1) Confirmation by NERC of the development of DisCos' customer databases and the initiation of power meter dissemination programs
- 2) Formulation, implementation, monitoring and supervision of DisCos' performance improvement plans (PIPs) and coordination with multi-year tariff rules (MYTO), TCNs' power transmission plans, etc.
- 3) Review of the work implementation agreements by Bureau of Public Enterprise (BPE) between BPE and respective DisCos, as well as the obligations of the parties concerned and the consequences of non-fulfillment of the agreements
- 4) Dispatching members of DisCos' Board of Directors with independent professionals through transparent procedures
- 5) Establishing a dedicated federal police department or dispatching police personnel to DisCos as required and state governments' appeals against outstanding charges by using district courts
- 6) Publication of DisCos', NBET's and TCN's audited financial reports and NERC monitoring reports on its website
- 7) NERC's instructions to NBET on contracts and invoices to purchase electricity at prices that can be considered affordable for DisCos and validating the contracts within the scope of authorization from the NERC, waiting for the DisCos to submit a letter of credit
- 8) Settlement of past accounts payable by government agencies
- 9) Issuance and implementation of government notices on the non-delayed payment of electricity rates by government agencies and promoting the efficient use of electricity by government agencies

- 10) Compensation for the cumulative deficit (USD 1.38 billion) due to low rate setting in the past (2015-2016)
- 11) Formulating and implementing financial support plans for deficits (USD 3.77 billion) until a cost-recoverable tariff system is established (2017-2021)

Table 10-1.1 shows the bill collection rate, defined as the ratio of the amount billed to users to the amount paid by users, of 39 Sub-Saharan African Countries given in a report issued by the World Bank Group issued in 2016. Nigeria ranked 36<sup>th</sup> out of 39 countries, fourth from bottom and about 90% of the countries were ranked higher than Nigeria (Collection rate of Nigeria in 2018 was 62%). It can be seen that the bill collection rate of Nigeria is very low compared to those of other Sub-Saharan African countries.

**Table 10-1.1 Bill Collection Rate in Sub-Saharan African Countries**

Collection Rate	Country	Rank
100%	Sudan	1 <sup>st</sup>
99%	Botswana, Gabon, Kenya, Mali, Mauritius, Seychelles, Swaziland, Uganda	2 <sup>nd</sup> – 9 <sup>th</sup>
98%	Burkina Faso, South Africa	10 <sup>th</sup> – 11 <sup>th</sup>
96%	Zambia	12 <sup>th</sup>
95%	Benin, Cameroon, Ghana, Rwanda	13 <sup>th</sup> – 16 <sup>th</sup>
.....	.....	.....
66%	Nigeria	36 <sup>th</sup>
60%	Madagascar	37 <sup>th</sup>
59%	São Tomé and Príncipe	38 <sup>th</sup>
58%	Comoros	39 <sup>th</sup>

Source: Financial Viability of Electricity Sectors in Sub-Saharan Africa, August 2016, World Bank Group

According to this and other reports, such as Energy Subsidy Reform in Sub-Saharan Africa (2013, IMF), major effective measures to raise the collection rate in highly ranked countries included: i) meter dissemination, including pre-paid meters and automatic reading and ii) awareness-raising and educational activities for users and campaign activities with users.

Although DisCos oversee these activities, it would be better for FMPEH and other relevant agencies to organize them, since boosting DisCo collection rates is essential for sustainable development of the power sector as a whole and there might be common issues and challenges nationwide.

As shown in Table 10-1.1, many neighboring counties far outperform Nigeria in terms of bill collection rates. Though some can be ranked far lower economically, it is recommended for FMPEH and other relevant agencies to incorporate good practices in these countries through observation tours and exchanges of views with stakeholders there.

As for spread installation and use meters, it can be suggested to develop and disseminate cheap, high-quality and durable equipment, optimally exploiting economies of scale by developing at the national level. Regarding user education, awareness-raising and campaign programmes, it is desirable to develop tools and manuals such as standard teaching materials and guidelines by hiring consultants and nationwide consultation with DisCos. It is recommended, however, to enable respective DisCos to customize the tools



and conduct educational and awareness-raising activities and campaign programmes corresponding to the diverse conditions in their service areas.

### **10-1-3 Promotion of IPP**

To meet future electricity demand, IPPs, private GenCos with a 100% share held by the private sector for on-grid electricity wholesale licensed by NERC, are expected to play an important role, as hydroelectric power companies, former Successor GenCos previously placed under the umbrella of Power Holding Company of Nigeria (PHCN) and GenCos that were constructed by National Integrated Power Project (NIPP) cannot meet the future demand for electricity. Unlike those companies constructed with public funds, IPPs are to be launched through private-sector funding and financing, which is primarily designed to pursue profits. For this reason, if no special support mechanism is provided, private capital will not enter the power sector, avoiding the high risk in the current power sector and promoting IPPs in response to the increasing demand for electric power will not be realized.

To promote IPP, the Government has to prepare conditions for tendering with sets of four contract forms, namely i) Power Purchase Agreement (PPA)/ii) Gas Sale Aggregated Agreement (GSAA), iii) Put and Call Option Agreement (PCOA) and iv) Partial Risk Guarantee (PRG) as prepared for selling GenCos constructed by NIPP and starting to apply the same in tendering for solar power IPPs. Under the conditions prepared by the Government with the four contract/agreement forms, tenderers will propose the generation charge or wholesale prices and the tenderer with the cheapest proposal will be awarded the contract. It is recommended to apply and further develop the procedure to promote IPPs. To effectively utilize, expand and further develop this procedure/mechanism, the institutional set-up has to be enhanced as follows:

First of all, there is a need for the related organizations to prepare tender documents properly and promptly. Accordingly, the relevant ministries and agencies have to prepare well-examined standard contracts/agreements with various options for diverse conditions and quick responses for individual IPP projects. At the preparatory stage it is important to prepare mechanisms that boost the motivation of the private sector for bidding and avoid any increased burdens on the Government after IPP operation gets underway. For this sake, relevant sections of the agencies, after mastering the four forms, has to prepare draft standard and individual contracts/agreement, with which the private sector will be effectively guaranteed or protected against the events for which they are not responsible, whereby the utmost utilization of private-sector capacity will be attained, the best endeavors of the private sector will be drawn out and the private sector will be rewarded in line with their performances.

In addition, the relevant ministries and agencies have properly evaluate the bid documents submitted by the tenders. Conformance with the Grid Code or other regulations by NERC, needless to say, has to be checked. The safety, security, stability and durability of the proposals of the tenderers also have to be swiftly evaluated before examining the offers on the wholesale price.

To facilitate and streamline preparation and evaluation, it is proposed to establish a taskforce with a leader from FMPWH, an advisor from the Federal Ministry of Finance and members from NERC, NBET, TCN, etc. Members have to devote themselves full time to the task, instead of having concurrent jobs. Members

should also have sufficient education and training opportunities, especially those of NBET who will be core persons for drafting standard and individual contracts/agreements.

#### **10-1-4 Promoting the Combined Cycle**

In Nigeria, the country that produces natural gas, the latter is a major source of energy for power generation because it is relatively inexpensive to obtain. In addition, although this leads to natural gas being used effectively, the combined cycle, which requires expensive equipment, has not been properly spread. There is a need to promote the combined cycle from perspectives of resource conservation and effective utilization, securing foreign currency through promoting export by processing to liquefied natural gas and achieving the targeted reduction in greenhouse gas generation.

In MYTO, the power generation tariffs were set according to capital investment costs, weighted average costs of capital (WACC), fuel costs and O&M costs (fixed and variable costs). While gas-use wholesale electricity prices differ for existing power producers and new entrants, capital investment costs, WACC, fuel costs and O&M costs (fixed and variable costs) for generation tariff setting were determined according to uniform thermal power generation parameters without distinguishing between single gas turbine generation and combined cycle generation. Accordingly, there was a possibility that the generation tariff setting was disadvantageous for the spread of the combined cycle generation. For each gas turbine generation and combined cycle generation, a measure to set parameters for each expenditure item can be considered, but cannot adequately reflect external diseconomies (air pollution, generation of greenhouse gases, etc.). The situation might continue even after introducing competitive wholesale prices. Despite scope for the external diseconomy to be reflected in environmental taxes, improving the environmental taxation system in Nigeria will be an issue in future. Simply, it is proposed that subsidies be provided for introducing combined cycle using a surcharge for gas turbine power generation as a source.

#### **10-1-5 Stable Supply of Natural Gas**

The main reasons why natural gas is not constantly supplied to GenCos are, as described in Chapter 3 in this report; i) insufficient investments to install and rehabilitate pipelines connecting gas production sites and power plants; and ii) frequent accidents occur to pipelines due to vandalism.

Concerning the above i), a) it is essential to keep the price levels of gas paid to the major producers above a certain level, but the price was raised from USD 0.3 to USD 2.5 per million BTUs in 2013 and 2014, the major producers of natural gas, such as Chevron, Shell, etc., continue to supply gas to the gas companies. b) There is also a need for GenCos to pay gas suppliers for gas purchases. c) Accordingly, there is also a need for wholesale electricity charges to be paid to GenCos from DisCos through the NBET and for d) DisCos to be able to recover all costs from users. Measures for realizing d) are proposed in 10-1-2.

Concerning above ii), actions are planned to be effective under the Power Sector Recovery Programme 2017-2021 (PSRP).

- 1) Determining priority development issues and projects in natural gas production areas and formulating and implementing priority projects

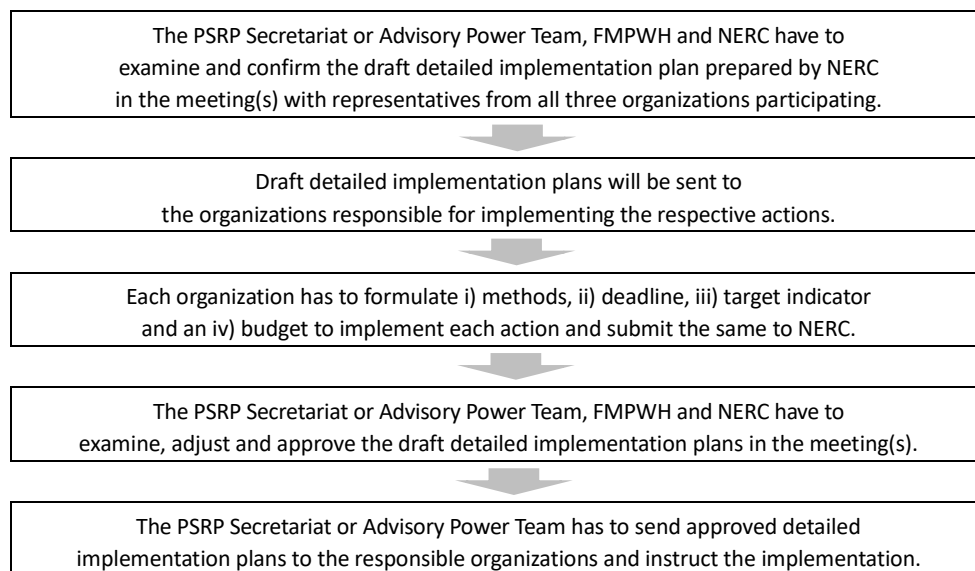
- 2) Sharing the stakes with local communities in natural gas-producing areas and providing incentives to preserve resources
- 3) Paying all outstanding amounts to gas suppliers via the Nigeria Electric Power Market Stabilization Fund
- 4) Managing the gas pipeline infrastructure development project

Because in some cases, vandalism might be deeply rooted in historical tribal conflicts between tribal disputes on resource allocation, there is a need to implement measures based on dialogs with and participation of local residents. Moreover, there is a need to fulfill the Comprehensive Agreement (GSAA) for gas supply based on collection of DisCo charges from users.

### 10-1-6 Steady Implementation of Power Sector Recovery Programme 2017-2021

The Power Sector Recovery Programme 2017-2021 (PSRP) is very concrete compared to other Nigerian policy documents in the power sector issued to date and can be said to have been prepared carefully based on understanding and insights into the current situation. In addition, actions necessary to restore and optimize the power sector as a prerequisite for implementing the Master Plan have been incorporated.

However, it appears that only limited actions have been implemented to date, despite around a year having elapsed since the issuance of PRSP. According to the results of interviews with relevant persons, it emerged that the reason why PRSP was not yet well implemented was the lack of detailed implantation plans and NERC has started formulating detailed implementation plans. As PRSP describes who is responsible for almost all contained actions, the following procedure would be recommendable:



Source: JICA Study Team

**Figure 10-1.1 Procedure to Formulate Detailed Implementation Plans of PSRP**

However, even for PSRP, there is a possibility that it will not be implemented given the risk of conflicts in implementing power sector reform and the fact that external pressure may be needed for the implementation. A number of donors are involved in the Nigerian power sector. It is expected that these

donors will cooperate and coordinate in monitoring PSRP progress, encouraging implementation and making financial assistance conditional on taking PRSP implementation steps.

## **10-2 Policy Recommendations to Improve the Power Sector**

### **10-2-1 Development of Reliable Basic Statistical Data**

Formulating realistic and achievable policies and plans depends on making justified demand forecasts, which lead to proper development of policies and plans, using reliable basic data.

The current basic statistical survey in Nigeria is the General Households Survey conducted every two years from 2010 with the cooperation of the World Bank. Around 5,000 sample households are included and the purpose of this survey is to collect panel data, with the same households surveyed in the past three surveys. The census was not last done in 2006 and the current population is only an estimate. Although issues such as security remain, more than a decade has elapsed since the last census survey. A census and consolidated collection and storage of basic statistical data are urgently needed.

### **10-2-2 Clarification of the Roles of the Ministries and Agencies in the Power and Energy Sector and Enhancement of Coordination**

Many ministries and agencies are involved in formulating policies in the power and the primary energy sectors. As pointed out in the PSRP, it is difficult to say that information-sharing among related ministries and agencies is closely conducted, and duplications and gaps exist in areas of responsibility, resulting in inconsistencies among policies and laws/regulations in some cases. It is expected that the communications policies outlined in the PSRP will be properly implemented for efficient and consistent policy formulation.

Regarding the formulation of policies concerning how renewable energy, petroleum and natural gas and coal are developed and utilized, the responsible agencies are scattered around various ministries and agencies. Under these circumstances, it is difficult to maintain consistency in policies to regulate the development and utilization and promote efficient energy utilization. Coordination among the relevant organizations is required. Cooperation among the related institutions is also required for effective energy demand forecasting and for determining the target values to be included in the policies on the primary energy. .

It is recommended that Energy Commission of Nigeria (ECN) regularly holds meetings with representatives from relevant organizations, such as FMPWH, the Federal Ministry of Petroleum Resources, the Federal Ministry of Mineral Resources and Steel Development, etc., to enhance cooperation and coordination among related organizations. It is expected that organization reform will be discussed to ensure coordinated formulation of the primary energy policies.

**CHAPTER 11    Cooperation with  
the Transmission Expansion Plan (TEP)**

## **Chapter 11 Cooperation with the Transmission Expansion Plan (TEP)**

During the first field survey conducted from 23 August to 21 September, 2015, it emerged that TCN was planning to implement the “transmission Master Plan;” supported by the World Bank (WB). Accordingly, the JICA study team met with WB officials during the study period and discussed an overview of this Master Plan and collaboration on mutual projects to obtain general agreement.

In addition, in December, the JICA study team met with WB officials and the Fichtner company (Germany) who contracted with TCN as a TEP consultant and shared the adjustment contents of both Master Plans and schedules to prevent large deviations in output by both Master Plan Projects to promote the implementation of the Nigeria development plan.

### **11-1 General Description of TEP**

The study is summarized below from the TOR of TEP and it is compared with the Master Plan in Table 11-4.3 “Comparison table between this Master Plan and TEP”.

- i) Project: Development of a Power System Master Plan for the TCN
- ii) Supervisory Organization: Federal Ministry of Power, Works and Housing  
Executing Agency: Transmission Company of Nigeria (TCN)
- iii) Contents
  - Current status survey on existing power facilities (transmission, generation)
  - Understanding of approved future plans (power transmission, power generation)
  - Transmission network plan based on power generation plan and demand forecast
  - Power flow analysis (static)
  - Power compensation analysis (reactor, capacitor)
  - Power system analysis (dynamic)
  - System fault calculation
  - Need for an ultra-high voltage transmission network  
Formulation of an optimum power system model
- iv) Study period: November 2015 - November 2016 (Final report was submitted in February 2018.)

### **11-2 Comparison between JICA and the Transmission Expansion Plan (Power Demand Forecast)**

TCN established a “Transmission Expansion Plan (TEP)” targeted from 2020 to 2037, which was created following an endorsement by the World Bank, in which the power demand (power load) up to 2037 is forecast. The following section compares the power demand of the Master Plan and the TEP power demand:

The power demands of the Master Plan are forecast in the following aspects

- Potential power demands are forecast under the condition of the potential demand survey in 2016. (It is “Actual demand +  $\alpha$ ” and known as “Computed Demand” in the report)
- Power demands are forecast under the condition of actual power demands including 2016.

(It is known as “Recorded Demand” in the report)

- Power demands separated by TCN, Auto Producers, Exports and Off-grid are forecast and their combination power demands are also forecast.
- Power demands of High, Base and Low Cases are forecast, each of which has different scenarios of the GDP growth rate.

The power demands of TEP are forecast under the following aspects:

- A potential demand survey in 2016 was issued to all DisCos. (Willingness of DisCo power supply) and the future TEP power demand was forecast assuming the potential demand surveyed in 2016 would be realized in 2020.
- The power demand of TEP comprises the total power demand; including domestic demand and exports from TCN. (i.e. TEP demand excludes Auto Producers and Off-grid).

The Master Plan and TEP can only be compared in terms of TCN demand (i.e. Domestic Demand + Exports), so it is implemented with only TCN demand.

Incidentally, TEP power demands are forecast every 5 years, with forecast years of 2020, 2025, 2030, 2035 and 2037. The results of the comparison are as shown in the following table. Moreover, “3) JICA (Low Case)” in the following table is applied for Master Plan and “5) TEP (Planning)” is applied for TEP.

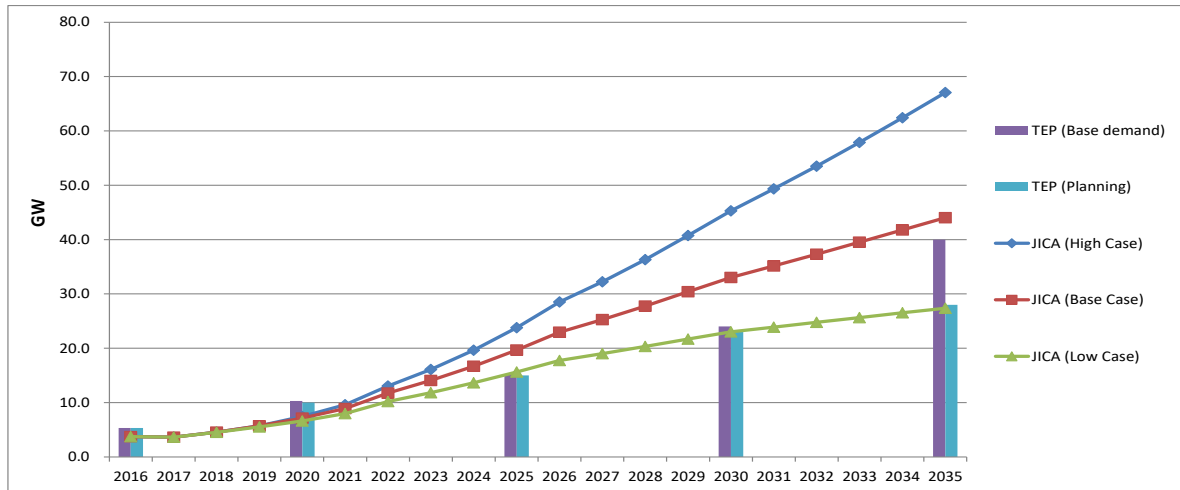
**Table 11-2.1 Power demands of Master Plan and TEP Power Demands**

	Unit GW								
	2016	2020	2025	2030	2035	20/16	25/20	30/25	35/30
1) JICA (High Case)	3.7	7.4	23.8	45.3	67.1	18.7%	26.2%	13.7%	8.2%
2) JICA (Base Case)	3.7	7.1	19.7	33.0	44.0	17.5%	22.5%	10.9%	5.9%
3) JICA (Low Case)	3.7	6.6	15.6	23.0	27.4	15.3%	18.8%	8.0%	3.5%
4) TEP (Demand)	5.3	10.3	15.3	24.0	40.0	17.8%	8.2%	9.5%	10.8%
5) TEP (Planning)	5.3	10.0	15.0	23.0	28.0	17.0%	8.4%	8.9%	4.0%

Source: Made by the JICA Study Team

Note: TCN power demand is Domestic Demand + Exports

Note: TCN power demand in the above table excludes Auto Producers, so the values in the above table do not correlate with the power demands in other tables in the previous session. For example, Auto Producers with 4GW are estimated in 2035, power demand including Auto Producers in 2035 is 31.4GW (=27.4GW+4GW) in the Low Case of the previous session.



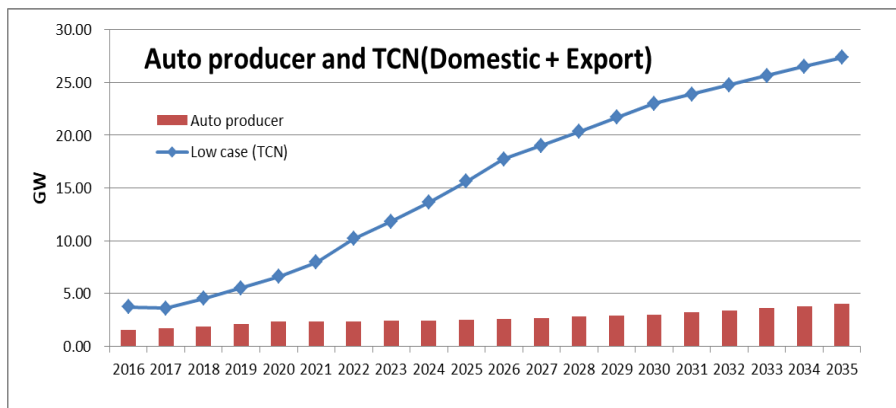
Source: JICA Study Team

**Figure 11-2.1 Power demands in the Master Plan and TEP**

The power demand of TEP only equates to TCN demand, including domestic demand and exports, so the power demand of the JICA study for making a comparable power demand to TEP has been changed via the following expression. The values here equate to the power demand for the Low Case in 2035:

$$\text{Domestic (30,718MW)} + \text{Export (673MW)} - \text{Auto Producers (4,000MW)} = \text{TCN demand (27,391MW)}$$

In the above expression, TCN demand without Auto Producers' demand is as shown in the following figure:



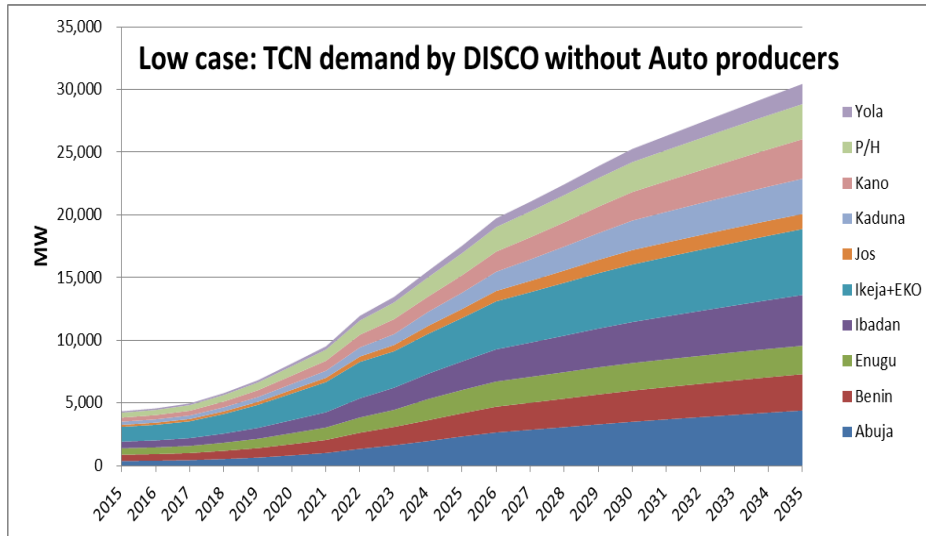
Source: JICA Study Team

**Figure 11-2.2 Auto Producer Demand and TCN Demand (Low Case)**

### 11-2-1 Power Demand for Transmission Expansion Plan

The power demand in the Low Case (without Auto Producers) for using the transmission plan is as shown in the figure below. The following DisCo total demand slightly exceeds TCN demand (Domestic + Export) in the Low Case (Above figure), because the coincidence factor (90%) is not applied to the following DisCo total demand.





Source: JICA Study Team

Note: Auto producer demands are subtracted from comparative large-scale DisCo demands

Note: “DisCo total demand \* 90% (Coincidence factor)” is almost equal to Low Case TCN demand

**Figure 11-2.3 DisCo wise peak demands (Low Case without Auto Producers)**

### 11-3 Comparison between JICA and the Transmission Expansion Plan (Generation Expansion Plan)

The difference between the Transmission Expansion Plan (TEP) and JICA’s Master Plan in terms of generation expansion plans is described as follows:

- (a) TEP does not consider nuclear power an expansion candidate but JICA’s generation expansion plan includes nuclear power plants in line with Nigeria’s policy.
- (b) TEP does consider hydro candidates identified under “Screening of potential hydropower options with associated water resources developments in the Niger basin” assisted by the World Bank but JICA’s generation expansion plan includes those hydro candidates.
- (c) Due to the difference in the power demand forecast used to underpin planning, TEP’s total generation capacity in 2037 is 48,823MW but the JICA figure is 54,927MW (+6,104MW).

### 11-4 Comparison between JICA and the Transmission Expansion Plan (Transmission Expansion Plan)

The difference between the “Transmission Expansion Plan” (TEP) and the transmission network development plan of this Master Plan is as follows:

This Master Plan is based on PSS/E analysis results, which reflect the current power system in Lagos and Ogun states provided from TCN and the project component planned by the JICA preparatory survey.

Since the estimated load demand in this Master Plan exceeds the estimated load in TEP, the estimated load demand for the target year differs, which is why some plans included in the post-2025 system expansion plan in this Master Plan are set earlier than the period in TEP.

**Table 11-4.1 Comparison of Maximum Load Assumptions in TEP and this Master Plan**

Master Plan	Load	2020	2025	2030	2035	2040
Transmission Expansion Plan	DisCo estimated Load (MW)	9,883	13,628	20,812	25,286	-
	Export (MW)	387	1,540	1,831	2,000	-
	Load Demand Assumption (MW)	10,270	15,168	22,643	27,286	-
This Master Plan	DisCo estimated Load (MW)	8,636	17,703	25,447	30,719	35,890
	Export (MW)	387	1,540	1,831	2,000	2,000
	Load Demand Assumption (MW)	9,023	19,243	27,278	32,719	37,890

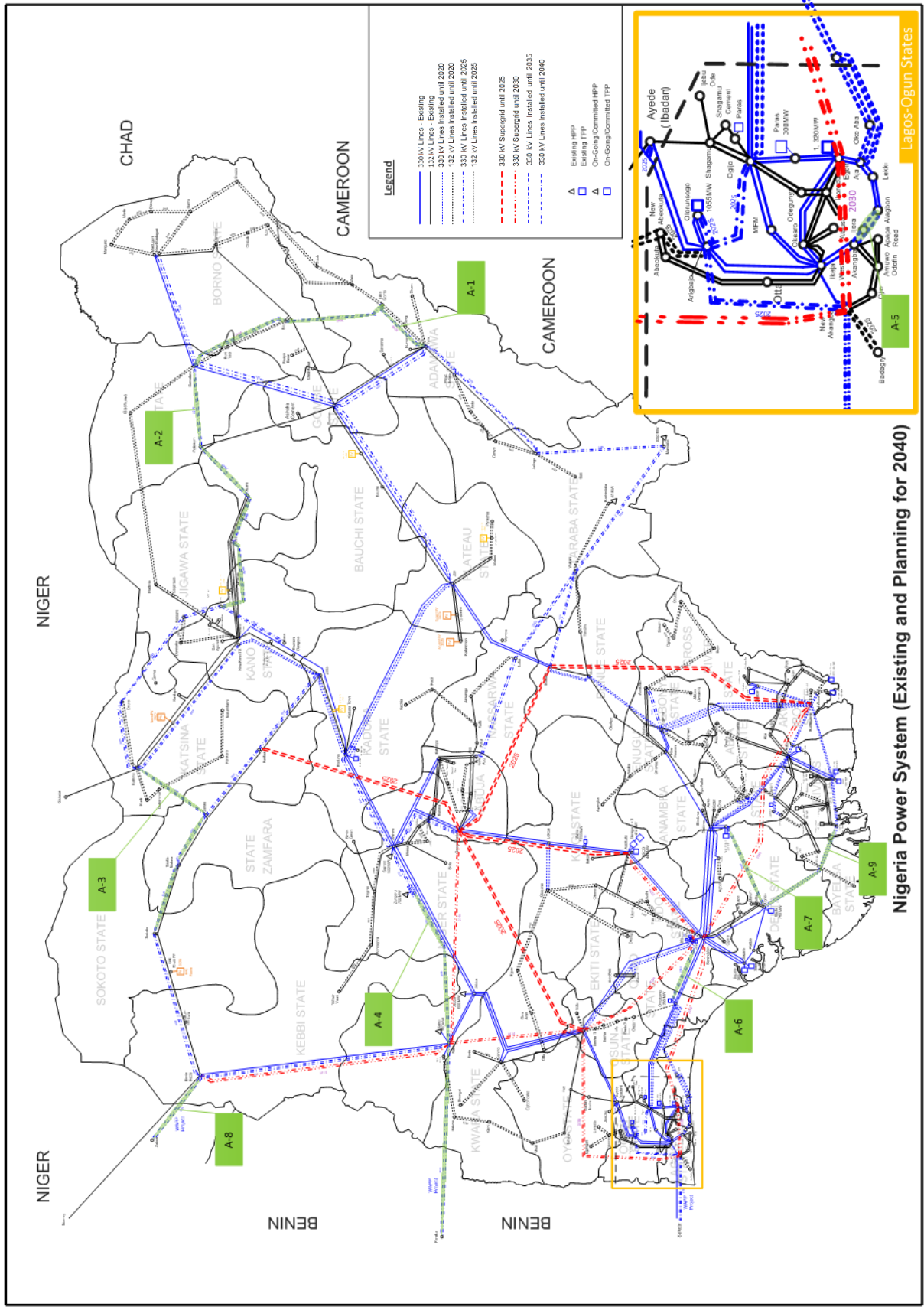
Source: JICA Study Team

Table 11-4.2 shows the list of 330-kV Transmission Lines requested by TCN after TEP. Every line was considered and most are recommended transmission lines (Apply: Yes) to the transmission network development plan of this Master Plan. Accordingly, transmission lines which were not considered in TEP are included in this Master Plan.

**Table 11-4.2 Additional 330 kV Transmission Lines requested by TCN after TEP**

330kV Transmission Lines	Apply	Transmission Line
330kV line Mambila-Kashimbila- Ogoja- Calabar	No	-
330kV line Yola-Little Gombi-Biu-Damaturu	Yes	A-1
330kV line Damaturu-Potiscum-Azare-Dutse-Jogana	Yes	A-2
330kV line Katsina-Sokoto (already considered in the TEP study by Fichtner)	Yes	A-3
330kV line Makurdi (Apir)-Ayangba-Ajaokuta	No	-
Zungeru to Kainji to Kaiama to Parakuay of Benin Republic (Mid-Core Project)	Yes	A-4
Akangba to Ijora to Alagbon (Closing of Lagos Loop)	Yes	A-5
Oshogbo to Ado Ekiti to Okene to Ajaokuta	No	-
Proposed Benin North (Ihovbor) to Omotosho through PPP business plan	Yes	A-6
Okpai to Ughelli	Yes	A-7
Birnin Kebbi to Niamey (North Core Project)	Yes	A-8
Ughelli (Delta) to Onne (Port-Harcourt)	Yes	A-9

Source: JICA Study Team



Source: JICA Study Team

Note: The applicable transmission lines are indicated with Green.

Figure 11-4.1 Additional 330 kV Transmission Lines requested by TCN after TEP

**Table 11-4.3 Comparison table between this Master Plan and TEP**

Project Title	JICA Master Plan Study on National Power System Development		World Bank Development of a Power System Master Plan for the Transmission Company of Nigeria	
	A-Outline of Work Item	Output	A-Outline of Work Item	Output
Master Plan	A-1 Development of Power System Master Plan	➤ Period: 25 years Base year: 2015 Short term: 2016 to 2020 Medium term: 2021 to 2030 Long term: 2031 to 2040	A-1 Development of a Power System Master Plan	➤ Period: 20 years Representative year: 2014 : 2020 : 2027 : 2033
Power Demand Forecasting	A-2 Outlook of isolated loads A-3 Outlook of Auto Producer A-4 Methodology of power demand forecast	➤ Power demand forecasting up to 2045	A-2 Same as on the left A-3 Same as on the left A-4 Regional load demand field survey at 11 Discos	➤ Power demand forecasting for 20 years
Power Generation Planning	A-5 Evaluate the availability of energy resources A-6 Least Cost Expansion Plan (LCEP) with WASP A-7 Evaluate the potential generation candidates to compile an optimal development plan	➤ Several scenarios by taking energy policy, primary energy development plan, supply and demand plan, energy security policy, renewable energy policy and environmental considerations (low carbonization) and LCEP into consideration will be examined and proposals made to develop an optimal development plan.	A-5 Same as on the left A-6 Same as on the left A-7 Same as on the left	➤ Based on the existing development plan, LCEP will be developed.